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STUDIES ON THE OPHIOGLOSSACEÆ

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THE family of the Ophioglossaceæ comprises the three genera—Ophioglossum, Botrychium and Helminthostachys, which are all evidently related, but whose affinities with the other Pteridophytes are not so clear, and there is a good deal of difference of opinion as to where they should be placed. Most botanists agree that the Ophioglossaceæ are related to the true ferns, but this view is not universally accepted, although the results of the more recent investigations tend to strengthen this conclusion.

The most marked feature of the family is the peculiar fertile leaf segment or spike; and the present paper is mainly concerned with the question of the morphologic nature of this sporophyll.

During the past year the writer had an opportunity of collecting a large amount of material of the Ophioglossaceæ in Ceylon, Singapore and Java. This included several species of Ophioglossum, one of Botrychium, and the monotypic Helminthostachys,— so that it has been possible to make a first-hand study of all the genera belonging to the family. The following account of the morphology of the leaf is based mainly upon a study of this material.

THE MORPHOLOGY OF THE SPOROPHYLL.

In all of the Ophioglossaceæ the sporophyll consists of a fertile and a sterile segment. The former (Figs. 1, 3, 4, 6, 7) is a stalked structure, the peduncle being often very long. The sporangia are in two rows in Ophioglossum, but in the other genera the fertile portion of the spike is more or less extensively branched,

this being very marked in the larger species of Botrychium. The two segments of the sporophyll may be almost entirely separate, *e. g.*, *Ophioglossum bergianum*, *Botrychium ternatum*, or the fertile segment may be apparently an outgrowth of the base of the sterile segment or from above its base.

The earlier views of the morphologic value of the fertile leaf segment were strongly influenced by the prevailing theory that the fertile portion was a secondary development of originally sterile leaf tissue, and therefore must be homologized with some portion of the sterile leaf. The belief more generally current at present that the fertile structures of the sporophyll are older than the sterile ones, inclines toward a different interpretation of the real nature of the fertile segment.

Bower (Studies in the Morphology of Spore-producing Members, II, Ophioglossaceæ. London, 1896) has given a very complete account of the different theories that have been advanced to explain the morphology of the fertile spike in the Ophioglossaceæ, and we shall merely give here a brief summary of the more important of these. Mettenius (Farne des Bot. Garten zu Leipzig. 1856, p. 119) regarded the two parts of the leaf as of equal importance, but gives no data as to their method of origin,—whether by the equal branching of a common primordium or otherwise. Later writers, *e. g.*, Holle (Bot. Zeit. 1875, p. 271) and Goebel (Schenk's Handbuch, vol. 3, p. 111) consider the fertile spike as the equivalent of the fertile pinnæ of such a fern as Aneimia. The former considers the single median spike to be the result of the coalescence of two lateral pinnæ; the latter as a single pinna which arises in a median position.

Bower himself has made the most complete study of the development of the spore-bearing parts of the Ophioglossaceæ that has ever been made. He concludes that the spike of Ophioglossum is morphologically equivalent to the single sporangium of Lycopodium. In this view he has the support of Strasburger (Bot. Zeit., 1873) and Celakovsky (Pringsheim's Jahrb., 1884, vol. **14**). Bower has, however, more recently described a most remarkable species of Ophioglossum (Ann. of Bot. **18**, p. 205, 1904) *O. simplex* Ridley, which makes possible another interpretation of the nature of the spike, *i. e.*, that it is a terminal and not a lateral organ. The writer (Mosses & Ferns, 2d edit., p. 600) in view of the dis-

covery of this remarkable form, has ventured the hypothesis that in *O. pendulum* the sporangiophore may also be terminal. In order to make a thorough investigation of the question, the collections of material already referred to were made and the results of this study and the conclusions to be drawn from it are given in the present paper.

THE GENERAL MORPHOLOGY OF THE SPOROPHYLL.

Ophioglossum.

The genus Ophioglossum comprises, according to Bitter (Engle- & Prantl, Die Naturlichen Pflanzenfamilien, 1 Theil. Abt. 4, p. 466) about thirty species, but it is probable that the number is much greater, as the species have not been critically studied in some regions where the genus is well represented. Bitter recognizes three sections of the genus, Euophioglossum Prantl, including most of the terrestrial species; Ophioderma Presl, with *O. pendulum* L. and *O. intermedium* Hooker; and Cheiroglossa Presl. with the single species, *O. palmatum*. The subgenus, Rhizoglossum Presl, is also sometimes recognized to include the single species *O. bergianum*.

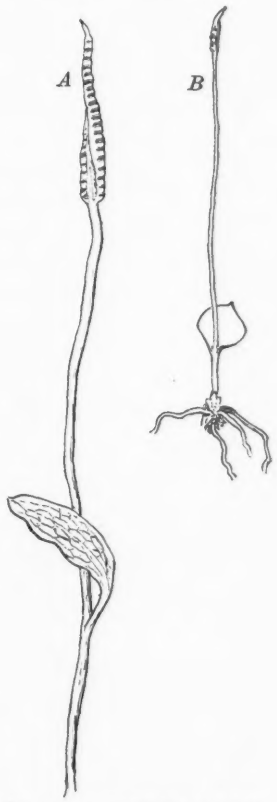

Fig. 1.— *A*, Sporophyll of *Ophioglossum moluccanum* Schlecht. natural size; *B*, Small form of *O. moluccanum* (?) natural size.

The great majority of the species belong to the first section, Euophioglossum. The writer collected a number of species in Ceylon and Java, but it was found very difficult to identify them, as in neither the collections at Peradeniya nor Buitenzorg was the genus well represented, and there is evidently very much confusion as to the species.

Raciborski, who has published a list of Javanese Pteridophytes (Die Pteridophyten der Flora von Buitenzorg, Leiden, 1898) gives only one terrestrial species, *O. moluccanum* Schlecht.; but it is evident from the writer's collections that there are at least four species belonging to Euophioglossum in western Java and possibly more.

FIG. 2. — Plant of *Ophioglossum simplex* Ridley × ⅔ (after Bower).

What seems to be the typical *O. moluccanum* (fig. 1, A) is a species of moderate size. The specimen shown has a sterile leaf somewhat smaller than usual, but otherwise is typical. One of the smaller forms of the same (?) species is shown in fig. 1, B. In both of these the sterile lamina is small, while the peduncle of the spike is very long and not very much inferior in thickness to petiole below the junction of the spike and the sterile lamina. Most of the other species of the section, *e. g.*, *O. vulgatum* L., *O. californicum* Prantl, *O. reticulatum* L., etc., agree in the main with *O. moluccanum*, and in none of these is there anything in the external morphology of the adult sporophyll to forbid the assumption that the sterile lamina is a lateral appendage of the spike.

The second section of the genus, Ophioderma, comprises *O. pendulum* L., *O. intermedium* Hook. and probably also *O. simplex* Ridley. In the latter species (fig. 2), which was discovered by Ridley in Sumatra, the fertile leaf consists of a narrow basal part without any lamina, terminated by a spike similar to that in *O. pendulum*, and it was assumed to be the nearest relative of this species. There is, however, no peduncle developed as is the case in *O. pendulum* and *O. intermedium*. It is well known that in *O. pendulum* (see Fig. 3) the short peduncle of the spike which apparently arises from the lamina itself, is continued into a sort of thickened mid-rib which is not developed above the insertion of the peduncle

of the spike, and the latter may very well be interpreted as the apex of the leaf, the lamina being lateral and closely coherent with its basal portion.

In all the species of Ophioglossum the growth of the basal part of the young sporophyll is very much more active than that of the lamina which remains relatively small, although the young spike is conspicuous in the early stages. This is especially marked in *O.*

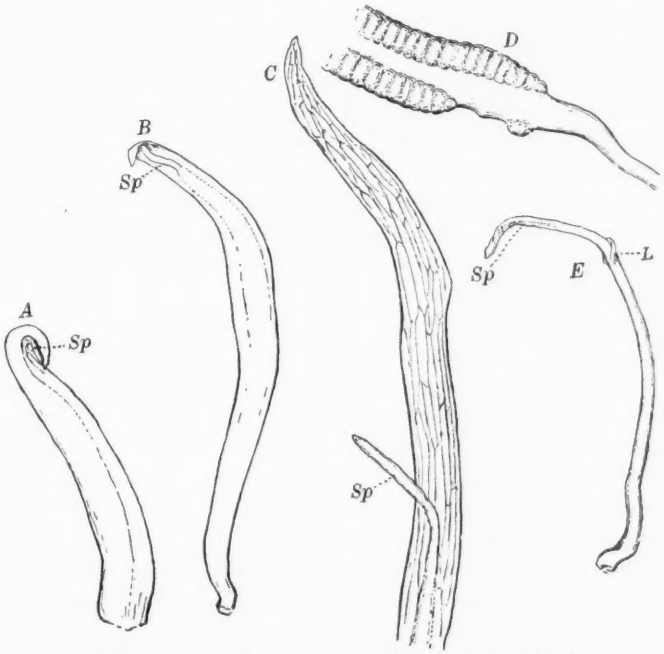

FIG. 3.— *A*, Young sporophyll of *Ophioglossum* (*Ophioderma*) *pendulum* L.. × 2; *B*, an older stage, natural size; *C*, a still older stage; *D*, base of a large spike, natural size; *E*, a small sporophyll in which the sterile lamina, *L*, is very greatly reduced, natural size.

pendulum (Fig. 3). This is the largest of the genus, and is a striking epiphyte of the moist tropics of the old world, extending, however, to the Hawaiian Islands. The specimens figured were collected in the botanical garden at Singapore.

In the youngest specimen shown (Fig. 3, A), the thick fleshy

leaf base terminates in a very small pointed lamina that is usually bent over, suggesting the circinate vernation of the true ferns. In most of the terrestrial species of Ophioglossum the young leaf is folded straight in the bud. Under the arched hood formed by the lamina is the young spike (*Sp.*) which almost equals the lamina in length.

Fig. 3, B, shows a somewhat older stage. The leaf has now become somewhat flattened, but there is no clear demarkation between the petiole and the small lamina. The fertile segment, which shows as yet no differentiation of the peduncle and spike, is conspicuous, and merges gradually into the thick petiole of the leaf whose margins are more or less distinctly winged and pass imperceptibly into the lamina above the insertion of the fertile segment. The interpretation of the latter as terminal and the sterile portion as a lateral appendage coherent with it would seem entirely plausible. An interesting case is shown in Fig. 3, E, where the lamina is almost entirely suppressed, and the terminal character of the spike is very evident.

As the leaf develops there is a very great increase in size of the lamina, which, in some of the largest individuals collected in Ceylon and Java, reached a length of one and one-half metres, or even more. These large leaves usually have the lamina dichotomously divided, and strikingly resemble the long drooping leaves of some species of Platycerium. Nevertheless even in these larger leaves the segments are quite destitute of a mid-rib. This stops at the base of the peduncle of the spike into which it is continued. The spike in these large specimens is correspondingly large, and sometimes attains a length of 25 to 30 centimetres, with a breadth of more than a centimeter (Fig. 3, D).

Undoubtedly allied to *O. pendulum* is the rare *O. intermedium* Hook. (Fig. 4). This is also perhaps the nearest ally of *O. simplex*. In the ordinary form (Fig. 4, A, B) this is not unlike a small specimen of *O. pendulum*, but it is rigidly upright instead of lax and drooping, the peduncle is longer and the lamina of the leaf much smaller and more sharply separated from the petiole. As in *O. pendulum*, however, the petiole is prolonged into the peduncle of the spike with the same mid-rib like thickening, caused by the coherence of the basal part of the peduncle with the lamina.

Even in the small number of specimens collected (the plant is an extremely rare one) a number of very interesting variations were found, some of which approximated quite closely the condition found in *O. simplex*. In these the lamina was greatly reduced, and in one case (Fig. 4, E) formed merely the narrow wing along the margin of the petiole and peduncle of the spike. In the other

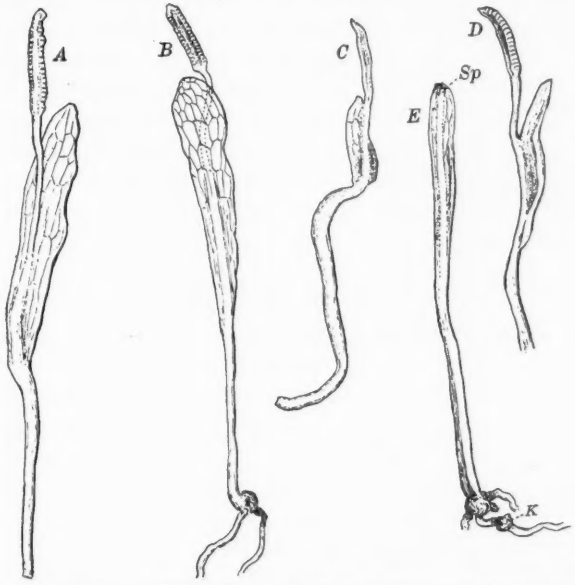

FIG. 4.— *Ophioglossum* (*Ophioderma*) *intermedium* Hook. several plants reduced about ½, showing variation in form; *K*, root-bud.

cases the lamina was wider and its apex free, but even in these the lamina was very small, and the terminal position of the spike extremely evident (C, D).

In both *O. pendulum* and *O. intermedium* the spike is more flattened than in the section Euophioglossum, and the central sterile portion wider in proportion. Stomata are almost entirely absent from the spike of *O. pendulum*, and the few that are occasionally found are confined to the central part. In *O. intermedium* the stomata are more numerous than in *O. pendulum*, but much less numerous than in *O. moluccanum*, for example, where they also occur upon the epidermis of the wall of the sporangium.

The third section, Cheiroglossa, represented by the monotypic *O. palmatum* L. of the American tropics differs from the others of the genus in having, usually, several spikes which are not generally borne in the median plane of the leaf, but are inserted near the margin. Bower (loc. cit., figs. 116–117) has shown that there may occasionally be a single spike which is then borne in the same position as in *O. pendulum*. He supposes that *O. palmatum* has been derived from the form with a single median spike like that of *O. pendulum* by branching of the spike, which not infrequently occurs in the latter species as well as in some others. The separation of the originally connected spikes he assumes has been the result of the great expansion of the lamina, which is much broader in *O. palmatum* than in any other species. Unfortunately the developmental history of the sporophyll in *O. palmatum* is quite unknown.

THE YOUNG SPOROPHYLL.

The differentiation of the two parts of the sporophyll takes

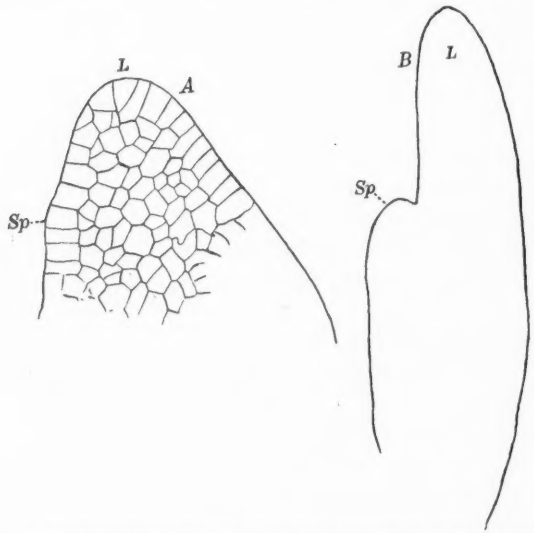

FIG. 5.— *A*, Nearly median section of a very young sporophyll of *O. pendulum*, × about 90; *B*, section of an older sporophyll, × 50; *Sp.* the apex of the spike; *L*, the sterile leaf-segment.

place at a very early period, and at this time the fertile spike is already evident as a conspicuous protuberance on the adaxial side of the leaf rudiment not far from its apex. Both divisions of the young sporophyll terminate in an apical cell, and both apparently grow in the same way.

Fig. 5, A, shows a nearly median section of a very young sporophyll of *O. pendulum*. This is a broadly conical body upon whose inner (adaxial) face there is a slight prominence (*Sp.*) the apex of the young spike. Fig. 5, B, shows an older, but still very early stage, in which it is evident that the spike rudiment extends completely to the base of the young leaf, with which it is adherent except at the extreme tip. The apex of the young spike is directed upward and its axis is almost parallel with that of the sterile leaf segment. From Bower's figures of corresponding stages in *O. vulgatum* it is clear that a very similar condition of things prevails in that species. In such a stage as that shown in Fig 5, B, the relation of the fertile and sterile segments is not unlike that of a stem apex and leaf, and the condition of things here present would very well lend itself to the interpretation of a terminal spike with a subtending sterile lamina. At this stage the vascular bundles are not yet differentiated, and the arrangement of these in the young leaf still remains to be made out.

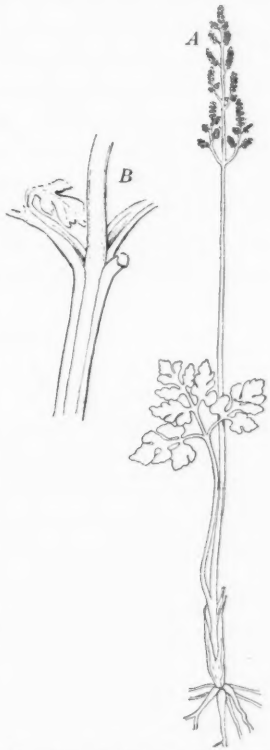

Fig. 6.— *A*, Plant of *Botrychium ternatum* Sw., × ½; (after Luerssen); *B*, base of the spike in *B. lanuginosum* Wall., slightly enlarged.

Botrychium.

In the second genus, Botrychium, most of whose species are plants of the temperate zones, both the fertile and sterile segments of the leaf as is well known, except in some

simple forms of *B. simplex*, are more or less extensively branched. This is especially marked in such large species as *B. virginianum* and *B. lanuginosum*.

The relation of the fertile and sterile periods is essentially the same as in Ophioglossum, and there is the same variation in the point of divergence of the two leaf segments. Thus in *O. obliquum* Muhl. the two are separated almost to the base. In *O. virginianum* and *O. lanuginosum* (Fig. 6, B) the spike appears to arise close to the lamina of the leaf or even above its base. No material was available for a critical study of this point in *B. virginianum*, but in *O. lanuginosum* Wall. where (see Engler & Prantl, loc. cit., p. 471) it is stated that the spike arises from the base of the sterile segment; even a casual examination will show that this is more apparent than real (see Fig. 6, B). If the leaf be looked at from in front it is very evident that the peduncle can be traced for a long distance below the bases of the sterile leaf segments, although only the anterior face is free, the inner face and sides being completely adherent to the base of the sterile segments.

HELMINTHOSTACHYS.

A similar condition to that found in *Botrychium lanuginosum* prevails in the third genus, Helminthostachys (Fig. 7), a monotypic genus of the Indo-Malayan region. This is much nearer to Botrychium, in its general morphology, than it is to Ophioglossum, although, in the character of both the prothallium and fertile spike, it is to some extent intermediate in character between the two genera.

In Helminthostachys the sterile segment, as in most species of Botrychium, is ternately divided, and the anterior margins of the stalks of the two lateral leaf segments are continued as more or less conspicuous wings enclosing the adherent base of the peduncle.

DISTRIBUTION OF THE VASCULAR BUNDLES.

A careful study of distribution of the vascular bundles of the leaf was made in most of the species that were available, to see

how far this harmonized with the theory of the terminal nature of the fertile spike. The arrangement of the bundles has already

FIG. 7.— *A*, Sporophyll of a small specimen of *Helminthostachys zeylanica* Hook., × ½; *B*, base of the spike, natural size.

been studied in the commoner European species, *O. vulgatum*, *O. lusitanicum* and *B. lunaria*. Bower has also investigated this in *O. bergianum*, and more recently in *O. simplex*, *O. pendulum* and *O. palmatum* (loc. cit. 1904). Of these forms the writer has examined *O. pendulum*, and in addition to this a number of other species which have not been hitherto studied.

In all of the species belonging to the section Euophioglossum that have been examined, there is given off from the vascular system of the rhizome a single leaf trace which divides at the base of the leaf into two strands. This is probably the case also in all the forms associated with *O. moluccanum* (see Fig. 8). According to Prantl, in *O. lusitanicum* each of these two bundles gives off a branch toward the adaxial side of the petiole which unite and

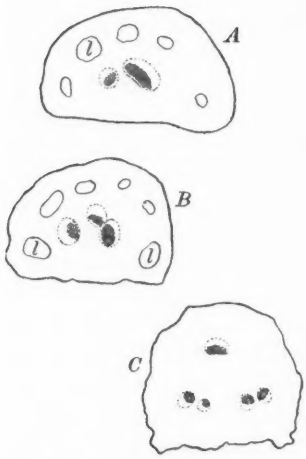

Fig. 8.—Three cross-sections of the lower part of the petiole of *Ophioglossum sp.*, × 25; *A*, *B*, at the base; *C*, higher up.

pass into the spike, the main trunks passing upward into the lamina. In the specimen shown in Fig. 8, which probably was not the typical *O. moluccanum*, while the leaf trace divides into two branches, as in *O. lusitanicum*, only one of these divided at the base of the leaf, so that at a point some distance above the base there are only three bundles, two of which are destined for the spike. The single bundle which is to supply the lamina is the result of the division of one of the two primary strands, the other half of which forms one of the adaxial bundles belonging to the spike.

O. MOLUCCANUM SCHLECHT.

A transverse section of the petiole in the typical *O. moluccanum*, made some distance below the point of separation of the two parts of the sporophyll (Fig. 9, A), shows four nearly equal vascular bundles, of which one is on the outer (abaxial) side, the other three on the adaxial side. As in all other species of Euophioglossum, these bundles are markedly collateral in structure. It is probable that the central adaxial bundle is due to the branching of one of the two adaxial bundles found near the base of the petiole.

If a section be made just below the point where the two parts of the leaf separate (Fig. 9, B), the three adaxial bundles are still recognizable, but the abaxial one has divided into several, which are evidently destined to supply the sterile leaf segment. A section taken a little higher up (C) shows plainly the bases of the two parts of the leaf. In the adaxial part, the peduncle of the spike, the original three adaxial bundles, are clearly evident, while in the lamina may be seen an increased number of bundles due to

the further ramifications of the abaxial bundles to form the reticulum of veins in the leaf segment. It is clear that in this species three of the four bundles of the petiole are continued unbroken into the spike, while only one of these contributes to the sterile leaf segment. This would certainly tend to confirm the view that the spike is the principal part of the leaf, and the lamina is secondary.

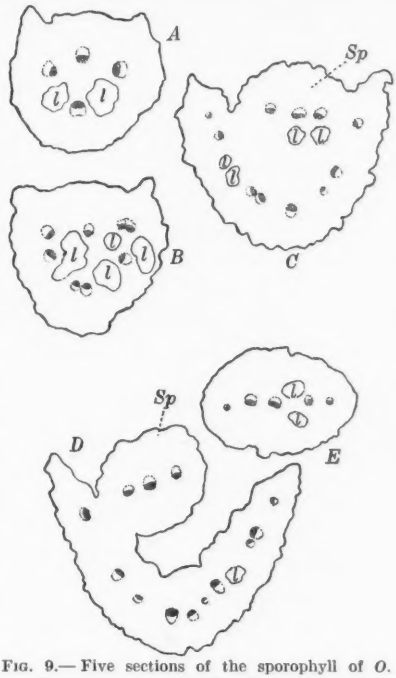

FIG. 9.— Five sections of the sporophyll of *O. moluccanum*; *A*, the petiole; *B*, *C*, intermediate; *E*, the peduncle of the spike; *l*, lacunæ; × 20.

The base of the spike (Fig. 9, C, D) shows the three bundles, but above the base (E) these bundles may branch, so that a section higher up shows five bundles. The ramifications of the veins of the fertile part of the spike were not studied in detail.

OPHIOGLOSSUM SP.

Fig. 10 shows sections of a second form of Ophioglossum, collected at Buitenzorg, evidently specifically distinct from *O. moluccanum*. It was a plant of about the same size, but it differed both in the cordate sterile leaf and in the size and other characters of the spores. It is probable that Fig. 8, which shows the extreme lower part of the petiole, also belongs to this species. The lower part of the petiole in cross section shows but three bundles instead of four, the middle adaxial bundle being absent. In a section taken near the junction of the spike and lamina there were four abaxial bundles and five adaxial ones. It is not exactly clear as to the relation of the latter to the ramification of the two pri-

mary adaxial bundles, whose identity is not so clearly maintained as in *O. moluccanum*. In a section at the base of the lamina the

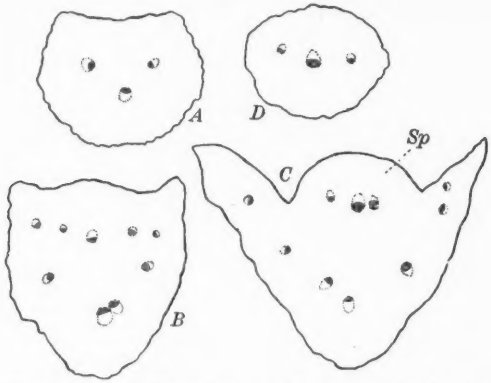

FIG. 10.— Four sections at different heights of the sphorophyll of *Ophioglossum sp.*; *A*, petiole; *B*, *C*, intermediate; *D*, peduncle; × 20.

arrangement of the bundles is very much the same as in *O. moluccanum*, and the three bundles of the spike are very similar. The triple arrangement continues into the spike, and a section made well above the base shows practically the same appearance.

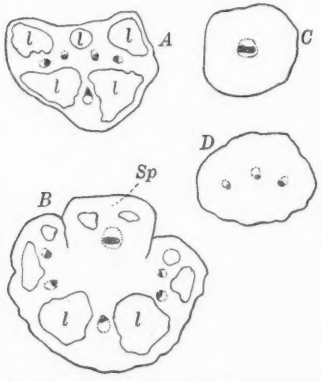

FIG. 11.—*Ophioglossum californicum* Prantl.; *A–C*, three sections of the sporophyll of a medium sized specimen; *D*, section of the peduncle from a larger specimen; × 20.

O. CALIFORNICUM PRANTL.

O. californicum is a small species from southern California. In the anatomy of the leaf it seems to follow pretty closely the description given by Prantl for *O. lusitanicum*. A section of the petiole (Fig. 11, A) shows four adaxial bundles, and a single abaxial one. If the section be made through the base of the peduncle and lamina (Fig. 11, B) the spike shows in some cases but a single large bundle, evidently formed by the coalescence of the adaxial bundles. There are five

bundles belonging to the lamina, of which the posterior one is apparently the original abaxial bundle, while the others are derived from the two outer of the four adaxial bundles. A large specimen which was examined showed three bundles in a transverse section of the peduncle (Fig. 11, D).

Ophioderma.

Bower has shown that in *O. pendulum*, *O. simplex* and *O. palmatum* there is not a single leaf trace, but the individual strands of the petiole join the vascular system of the rhizome directly. He also showed that the adaxial bundles which supply the spike in the fertile leaf of *O. pendulum* are quite absent from the petiole of the sterile leaf, which in section shows no bundles at all on the adaxial side. In the section Ophioderma the upper part only of the peduncle is free, the lower portion, as we have seen, being adherent to the lamina and merging insensibly into the common petiole of the sporophyll. Fig. 12 shows four sections at different heights from a leaf of *O. intermedium*. Near the base of the petiole there are five vascular bundles, of which the two on the adaxial side are noticeably larger than the three abaxial bundles. Somewhat higher up there are four adaxial bundles, evidently the result of a bifurcation of the two which are seen lower down. The three abaxial bundles remain unchanged except that they are somewhat further apart, corresponding to the broadening of the petiole at this point. Still higher up, where the base of the peduncle is coherent with the lamina, the former may be seen projecting somewhat from the leaf and containing three bundles, and the same number occurs in the free portion of the peduncle (Fig. 12, C & D).

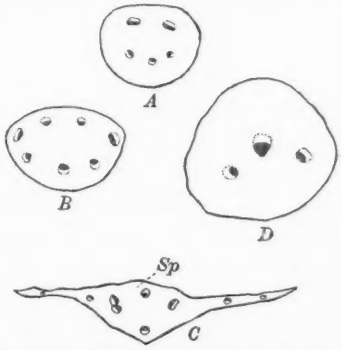

Fig. 12.— *Ophioglossum intermedium*; *A–C*, three sections of the petiole and lower part of lamina, × 6; *D*, section of free part of peduncle, × 20.

The very much larger leaves of *O. pendulum* show a correspondingly larger number of vascular strands. Fig. 13, A to D, shows sections through the petiole, base of lamina, and spike of a medium size specimen. In the former eighteen bundles could be seen, of which probably seven or eight are destined to supply the spike. In the basal part of the lamina six or seven adaxial bundles are plainly visible below the slightly projecting region which marks the coherent portion of the peduncle. In both this species and *O. intermedium* the free portion of the peduncle is comparatively slender, and the number of bundles less than in the broader basal part. In the specimen figured there were three bundles, of which the middle one was evidently doubled, and was clearly formed by the coalescence of some of the bundles before they left the adherent part of the peduncle. Higher up there were five bundles arranged in a semicircle. The same arrangement was found in the peduncle of a larger specimen (Fig. 13, E) taken from the spike which is shown in Fig. 3, D.

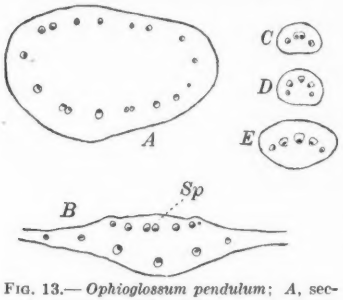

FIG. 13.— *Ophioglossum pendulum*; *A*, section of the petiole of the sporophyll; *B*, section of the base of the lamina and coherent peduncle, *Sp*; *C*, *D*, two sections of the free portion of the peduncle; *E*, section of the peduncle from a larger specimen; all figures × 4.

The complete absence of the adaxial strands in the petiole of the sterile leaf, even at its base, is a strong confirmation of the view suggested by both the older leaf and the younger stages that the peduncle really extends to the extreme base of the petiole and is joined directly to the rhizome.

BOTRYCHIUM.

The only species of Botrychium available for study was *O. lanuginosum* Wall. collected at Horton Plains in the uplands of Ceylon. The arrangement of the bundles in the leaf of this species agrees in the main with that of the other species that have been studied (see Bitter, loc. cit., p. 458). The leaf trace divides into

two at the base of the petiole, and these branches divide again somewhat higher up (Figs. 14, A to C). Of the four bundles thus formed, the two larger adaxial ones are those which supply the spike, the smaller abaxial ones supplying the lamina. In larger

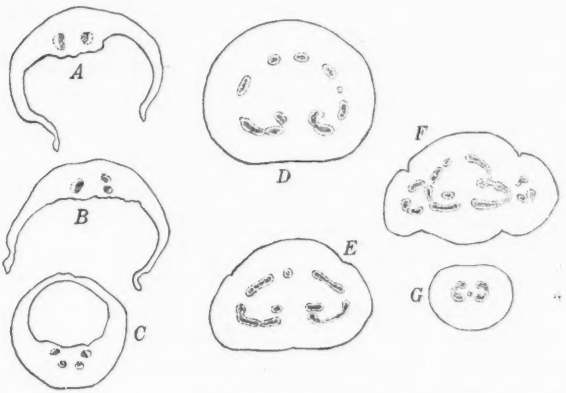

FIG. 14.— *Botrychium lanuginosum*; *A*, *B*, *C*, Sections through the base of the petiole; in *C*, the position is reversed from that of the others; *D–G*, sections of the petiole and upper part of the sporophyll of another specimen; × 4.

specimens of this species (Fig. 14, D), and the same is true in *B. virginianum*, there may be a subsequent branching of some of the bundles, so that a cross section of a stout petiole shows a larger number of bundles, sometimes as many as ten.

Sections made at the junction of the spike and lamina (Fig. 14, E) show anastomoses of some of the bundles which appear elongated in section, but there seems to be no regular rule governing the fusion of these. It is not quite clear whether any branches are given off from the spike bundles into the lamina, but this is probably the case in regard to the two lateral segments of the lamina. Within the peduncle of the spike in the larger specimens (Fig. 11, G) the two original bundles are again clearly defined, but in some of the smaller specimens these may be completely united into a single central bundle.

HELMINTHOSTACHYS.

Farmer & Freeman (On the Structure and Affinities of Helminthostachys zeylanica, Ann. of Bot. **17**, p. 421, 1899) state that in Helminthostachys there is, as in Euophioglossum and Botrychium, a single leaf trace which afterwards divides into several, usually seven or eight, within the petiole. As we have already seen, although the spike in Helminthostachys arises apparently from the base of the lamina, in reality its origin is lower down, and it may be traced for a long distance below the insertion of the sterile segments.

In a section made near the base of the petiole, it appears almost circular in outline with a ring of separate bundles. On the adaxial side, however, there are two other bundles within the outer circle. The number of bundles in the larger specimens collected by the writer was decidedly greater than that given by Farmer & Freeman (see Fig. 15, A). Higher up the section is no longer round, but slightly lobed, indicating the bases of the three branches of the ternately divided lamina, and on the adaxial side can be plainly seen a fourth lobe, which marks the position of the spike. This is bounded by two more or less conspicuous bodies, the sections of the wings that extend down the petiole from the lateral leaf lobes (Fig. 15, B & C). In this region the separate bundles of the basal part of the petiole are more or less coalescent, but the two adaxial bundles remain separate and are those which later extend into the spike. Still higher up the spike becomes more evident, and the two bundles belonging to it still more clearly separated. In the free portion of the peduncle the two crescent shaped bundle

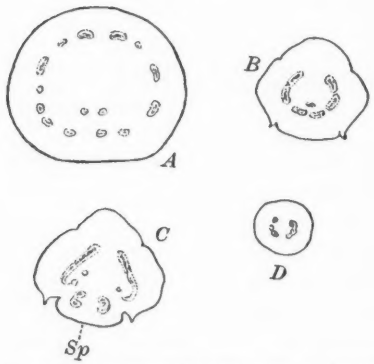

FIG. 15.— *Helminthostachys zeylanica*; *A*, section of the petiole of a large specimen, near the base; *B*, *C*, sections higher up, of the petiole of a smaller specimen; *D*, section of the peduncle; × 15.

sections are seen (Fig. 15, D), but it is evident that they are really composed of several coalescent bundles. A slight indication of this can be seen also in the adherent basal portion of the peduncle.

CONCLUSIONS.

From a study of the distribution of the bundles in the leaf it is evident that the bundles which supply the spike are not secondarily given off from the main bundles of the petiole, but are themselves the adaxial bundles which can be traced from the base of the petiole into the spike. This would indicate that the spike is not a secondary development upon the leaf, but is a primary portion of it. From a study of the earlier stages of the young sporophyll as well as from the conditions shown in *O. simplex* and certain forms of *O. pendulum* and *O. intermedium*, there seems to be little question that the spike is really a terminal structure, and the writer is inclined to believe that in all cases the spike may be regarded as the apex of the leaf structure and the lamina as lateral with regard to it. If this view be not accepted, it would seem necessary to return to the old view of Mettenius, that the leaf is divided into two equal branches.

FIG. 16.— Section of the prothallium, *Pr*, and young sporophyte of *Ophioglossum moluccanum*; the latter consists simply of the terminal leaf, *L*, and the primary root, *R*; × 15.

In connection with the question of the terminal position of the sporophyll, the position of the leaf in the embryo may be cited. In *O. moluccanum* — and the same is true in *O. pedunculosum* described fifty years ago by Mettenius,— the young sporophyte (Fig. 16) develops at first only a leaf and root, the definitive sporophyte arising later as an endogenous bud from the primary root. The first leaf must be considered a strictly terminal organ. This embryo corresponds exactly to what might be expected if the hypothesis advanced by the writer — that Ophioglossum probably arose from some form resembling Antho-

ceros — be true. This hypothesis assumes that, by the development of a root from the lower part of the sporophyte and a complete septation of the sporogenous tissue of the sporogonium so that something resembling the spike of an Ophioglossum resulted, there would be formed a plant not very unlike *O. simplex*. We actually have in the embryo sporophyte of *O. moluccanum* a plant which consists simply of leaf and root. Of course the leaf is not sporogenous, but the ancestral form must have developed a sporogenous structure comparable to the spike before the foliage leaf arose. The latter presumably was formed as a lateral outgrowth of the sporogenous portion, as there seems to be some evidence is the case in the young sporophyll of the living species.

THE AFFINITIES OF O. INTERMEDIUM HOOKER.

Ophioglossum (*Ophioderma*) *intermedium* Hook. is apparently a very rare plant. It was originally described by Hooker from

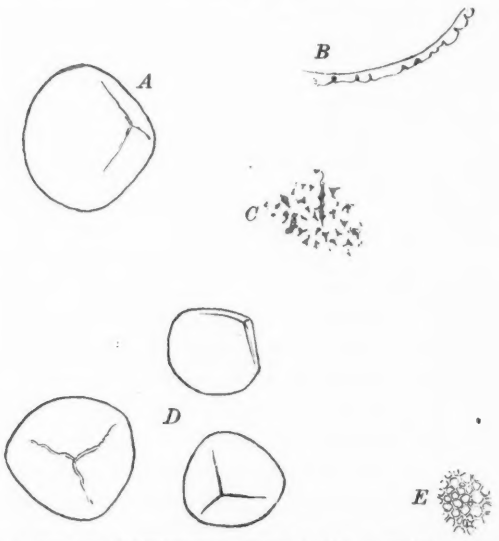

FIG. 17.— *A*, Spore of *Ophioglossum pendulum*, × 500; *B*, optical section of the wall of the spore, more highly magnified; *C*, surface view of the markings of the spore-membrane; *D*, three spores of *O. intermedium*, × 500; *E*, markings of the surface of the spore.

material collected in Sarawak in Borneo. When the writer was in Singapore inquiries were made at the botanical gardens as to the possibility of obtaining material of this species, but it was found that the original locality was lost, and the plant had not apparently been collected since it was first sent to Hooker.

The writer, however, found that this species had been collected near Buitenzorg by Mr. J. J. Smith, of the herbarium of the garden there. He was kind enough to accompany the writer to the place where it had been collected, and it was thus possible to obtain a fair amount of material which was enough to show that the plant is certainly quite distinct from *O. pendulum*, of which it has been supposed (Bitter, loc. cit., p. 469) that it was a mere form, perhaps due to its terrestrial habit. In Buitenzorg it grew in a plantation of bamboo — usually in the accumulation of humus and earth about the roots of the clumps of bamboo. It is a small plant (see Fig. 4) and in its stiff upright habit and much longer peduncle presents a very different appearance from any form of *O. pendulum* — although it is evident that it belongs to the same section of the genus. The plants grew from a small tuberous body apparently developed as a root bud (Fig. 4, B, E) and in this respect as well as in the occurrence of such forms as that shown in Fig. 4, E, where the lamina is almost wanting, it approaches *O. simplex*, with which it may be pretty closely allied. It differs, however, in other respects than that of its habit, from *O. pendulum*. The spores (Fig. 17, D) are decidedly smaller than those of *O. pendulum*, and the delicate reticulate markings of the epispore (Fig. 17, E) are very different from the markings in the latter species.

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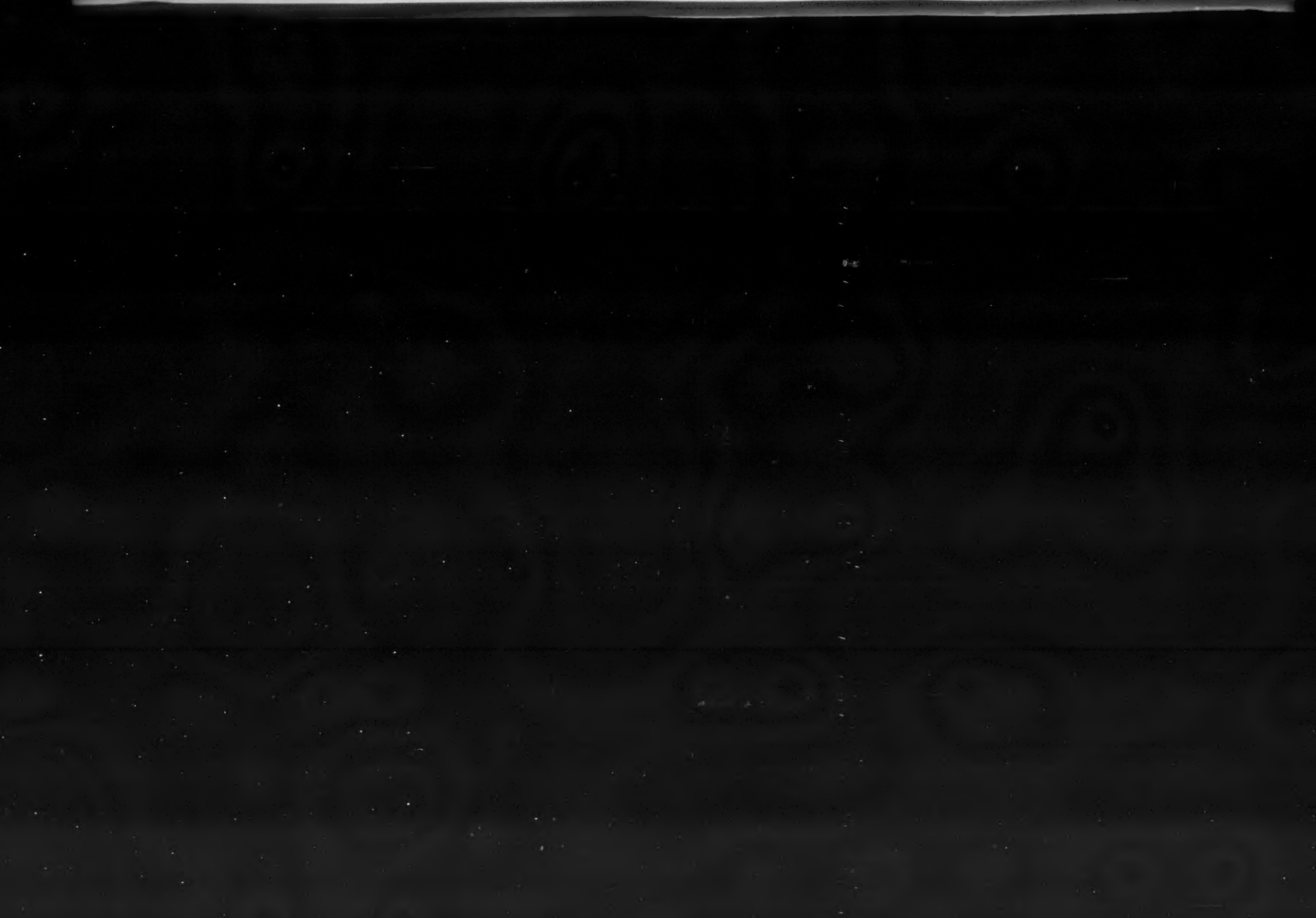


POLYGAMY AND OTHER MODES OF MATING AMONG BIRDS

R. W. SHUFELDT

For several years I have devoted much time to a study of the phenomena of sex in vertebrates, comparing those of the lower forms with the features presented by man. Much of the matter thus obtained is now in the publisher's hands but some of it is presented here.

The nature of man, his customs, habits, and institutions, his mental and physical characteristics cannot be fully and intelligently understood unless all of our stock of accumulated facts are studied in the light of what we know to obtain along the corresponding lines among all animals below man. That is to say, it is simply impossible to comprehend the morphology of man, unless our studies of it are made comparative with our knowledge of the anatomy of all other animals. So too with all else manifested on the part of our species;— to get at the origin of all things in man and his customs, his crimes, and his passions, we are obliged to trace them down through the scale of living forms below him. It holds in our researches into the science of society, and it was Letourneau who said "When once it is established that man is a mammal like any other, and only distinguished from the animals of this class by a greater cerebral development, all study of human sociology must logically be preceded by a corresponding study of animal sociology. Moreover, as sociology finally depends on biology, it will be necessary to seek in physiological conditions themselves the origin of great sociological manifestations." [1]

It has been recently, with such thoughts as these in mind, that I have been making some comparisons of the various forms of marriage as we find it among different races of mankind; the question of divorce; and the part played in the marital relations by sexuality. Following the biological methods of comparison

[1] The Evolution of Marriage, p. 2, 1900.

and derivation, I attempted to bring together what I knew of the matter of mating among animals generally, carrying my investigations into the various groups of fishes, reptiles, birds and mammals. It is a very well known fact that with respect to our own species, we meet in one part of the world or another, people who practice every form of sexual relation, to say nothing of what is met with along the lines of pervertism in such matters. Even in the United States, we meet with any number of cases of marriage devoid of all ceremony (anarchists); of free love; of monogamy; of promiscuity; of polygamy and bigamy; of legalized concubinage (South Carolina); and of the divers unnatural relations of the sexual perverts and inverts. Polyandry, that rare and exceptional conjugal form, where the one wife has two or more husbands, has never been instanced among us, so far as I am aware. No such sexual association is met with among mammals below man, and never among birds.

It is in this latter class of vertebrates that we meet with some of the purest types of, as well as some of the most interesting examples of the conjugal relation, and it is to a comparative consideration of some of these that the present article will be devoted.

In reviewing the material for this purpose at hand, I have drawn largely upon my own ornithological observations and studies extending over a period of forty or more years. Then I have consulted such works upon ornithology as I find in my private library. With respect to the latter, I am obliged to confess my surprise at the inadequacy of the accounts, and the marked variance often exemplified in the statements of different authors of recognized standing and reputation on the subject. Very few books at my command pretend to make any comparisons between the mating habits of birds and the marriage customs of various peoples, but there are a few.

Beyond the matter of the different procedures of courtship in the case of birds, there are no further ceremonials with them as in the case of many, indeed, the majority of the races of mankind. So that, in the abstract, polygamy in birds means exactly the same thing as human polygamy, and so on for monogamy, promiscuity and other practices. Taken in the abstract, and barring opinions to the contrary, many believe in the case of man, that

in prehistoric time, when he was first differentiated from simian stock, he, wherever existing, was given over to unmixed promiscuity; that this was soon followed in many regions by some form of polygamy, and polyandry where women were scarce (rare); as promiscuity disappeared, and polygamy became far less prevalent, some mode of monogamy appeared, and this, at the present time is the form of marriage adopted by nearly all civilized races. In other words these various customs have shaded into each other, —that is, in the main, promiscuity for the wild, prehistoric people; followed by polygamy for ancient times, with monogamy now ever on the increase. Still we must bear well in mind that we have polygamy now openly followed in the United States, and some of the lowest existing races of the world are monogamous.

These facts are thus briefly presented in that we may contrast them with what occurs in the class of birds. Theoretically, in one way, the lowest forms of existing birds should in their mating be given over to promiscuity; those higher in the scale should be polygamous; and, finally the most specialized types, as the Passeres, be monogamous. This, however, is by no means the case, and agreeing with our own species, some of the existing groups of birds most nearly related to extinct types, closely associated with reptilian stock, are strictly monogamous, while others perhaps, are promiscuous (no birds being polyandrous); and still others affording examples of polygamy. So it is too, higher up in the scale, just as it is, as before remarked, with the human species.

Tracing birds back through geologic time as best we can by means of the material at hand there is no question but what in their morphology they approached nearer and nearer the archaic types of reptiles. Avian and reptilian osteology especially emphasizes this fact, and it is well known that some of the existing families of birds from various parts of the world exhibit in their skeletons characters that were more or less common to the entire class Aves as represented in that age of the Earth's history when birds had first become more or less differentiated from their reptilian ancestry. This by no means implies, however, that the present day existing families of birds, in the osseous systems of which still are to be met with those more pronounced evidences (in the

way of characters) of their reptilian relationships, are distinctly more closely allied upon that account. Many taxonomers, however, have thought so; and have endeavored to show that all existing true ostrich forms, the Kiwis, and tinanous are a sort of modern affined struthious types. On the other hand a Kiwi (Apteryx) is no nearer an ostrich, and an ostrich to a tinamou, than a limpkin (Aramus) is to a bustard, and a bustard (Otis) to a quail (Colinus). Therefore it need not surprise us, in view of all that has been set forth above, that the various modes of mating of any of these birds should be entirely different, or that these modes should fail to throw any light upon their affinities. For a moment then let us see what some authors have to say in regard to the mating of ostriches and their allies.

Professor Newton, quoting Lichtenstein, says: "Though sometimes assembling with Zebras or with some of the larger antelopes, ostrichs commonly, and especially in the breeding season, live in companies of not more than four or five, one of which is a cock and the rest are hens. All the latter lay their eggs in one and the same nest, a shallow pit scraped out by their feet, with the earth heaped around to form a kind of wall against which the outermost circle of eggs rest. As soon as ten or a dozen eggs are laid, the cock begins to brood, always taking his place on them at nightfall surrounded by his wives, while by day they relieve one another, more it would seem to guard their common treasure from jackals and small beasts-of-prey than directly to forward the process of hatching, for that is often left wholly to the sun."[1] From this it is clear that the African Ostrich is a polygamous bird by nature.

The Rhea or South American ostrich (*Rhea darwini, americana*, etc.) is also undoubtedly polygamous in nature, while the emeus of Australia are said to be monogamous, though neither Newton or Pycraft[2] say anything on this point. Neither do they give us any information on this point in regard to the cassowaries, birds

[1] Newton, Alfred. *A. Dictionary of Birds.* Part III, Art. "Ostrich," pp. 664–665, 1894, quoted from M. H. K. Lichtenstein, *Reise im südlichen Africa*, ii, pp. 42–45 (Berlin: 1812.). The fact that the sun assists in hatching the eggs of the African ostrich is disputed, but it is doubtless true. Captive ostriches are usually enforced to lead a life of obligatory monogamy.

[2] Pycraft, W. P. *The Living Animals of the World.* Vol. II, p. 394, London (no date).

more or less closely allied to the emeus. Indeed, I am unable to state whether a cassowary is, by nature, polygamous or monogamous. Their eggs have been described but apparently not their mating habits. None of the above-named writers describe the breeding habits of the kiwis (*Apteryx oweni*, *mantelli* and *australis*) and I am unable from personal observation to state whether they are by habit monogamous or polygamous (see Sir Walter Buller, Newton, Pycraft, and other writers). These curious birds, now being rapidly exterminated, are probably monogamous, as Dr. Claus says of them, "The kiwis are nocturnal birds, which by day remain concealed in holes in the earth and go out at night to seek their food. They feed on insect-larvæ and worms, live in pairs, and at the breeding time, which seems to come twice in the year, they lay, in holes scraped in the earth, a strikingly large egg, which, according to some, is incubated by the female, and according to others by the male and female in turn." [1]

So far as I have been able to ascertain, the tinamous (Cryptoturidæ) are monogamous birds, while they associate together in flocks during those times of the year when they are not breeding. Newton does not mention this in the "Dictionary," and at this writing I do not happen to have Bartlett's paper at hand (P. Z. S. 1868, p. 115, pl. xii). In fact there are but very few good accounts of the breeding habits of these very interesting birds. Their wonderfully beautiful eggs are well-known to naturalists.

All water birds of the main groups appear to be monogamous in the matter of their mating. There appear to be no exceptions to this rule to be met with among the several suborders of the Pygopodes, Impennes, Tubinares, Steganopodes, Longipennes, Alcæ, and the Chionides. As we know, these groups contain the divers, the penguins, the petrels, the pelicans and various allies, the gulls, and the auk tribe. Nearly all these forms are low in the scale, and in all we meet with near relatives among birds that are extinct and certain fossil types. Yet, as I say, they are all monogamous so far as my knowledge carries me. Passing next to the great limicoline assemblage (Limicolæ), it is to be observed that it contains, with their numerous allies, the

[1] Claus, Dr. C. Elementary Text-book of Zoology. Translated by Sedgwick and Heathcote. Pt. ii, p. 272, 1885.

plovers, the turnstones, the surf birds, the snipes, the phalaropes, the avocets, and the jaçanas, the entire host being monogamous by habit, with but one famous exception, namely, the truly polygamous ruff (*Machetes pugnax*). The peculiar habits of courtship and breeding practiced by this species have been well-described by a number of continental naturalists.[1] Among the Limicolæ there appears to be, among existing birds, but one other species suspected of being a polygamist, and this is the double or solitary snipe (*Scolopax major*) of Europe. Newton does not mention the fact in the "Dictionary," but Darwin remarks in "The Descent of Man," that "some of the above birds,— the black-cock, capercailzie, pheasant-grouse, ruff, solitary snipe, and perhaps others, are, as is believed, polygamists." (p. 406.) From all that I can gather, it would seem that the question has not yet been decided. Coming to the Cursoræ, the group contains but few species that I know of, that have been suspected of being polygamists and among these is the great bustard (*Otis tarda*),— and with it most of the evidence seems rather to point to the fact, that such is the case. Whether any other representatives of this somewhat numerous group (Europe, Africa, Asia, and Australia) are polygamous by habit, I am unable at present to say. However, the birds called 'floricans' of India, closely allied species to the bustards, are reported as practising polygamy. There seem to be two known species of these, — the Bengal (*Sypheotides bengalensis*) and the lesser florican (*S. aurita*). During pairing season the two sexes live apart in groups, and in mating come together, and "when a male wishes to attract a temporary partner, he does so by going through an elaborate series of performances."[2] It is possible that all the true bustards possess strong inclinations in this direction, even if they are not actually polygamists. Not so, however, with the stone curlew (*Œ. crepitans*) a species I have relegated to the Cursoræ, although, I by no means consider it to be very closely allied to the Otididæ.[3]

[1] See A. Newton, art. "Ruff." Dict. Birds, Darwin, "The Descent of Man," p. 219, Montagu (*Suppl. Orn. Dict.* 1813); Pennant, Daniel, Graves, Collett, Lubbock, Southwell, Stevenson and others.

[2] Lydekker, R. *The Royal Nat. Hist.* p. 458.

[3] Shufeldt, R. W. "An Arrangement of the Families and the Higher Groups of Birds." *The Amer. Nat.*, Vol. **38**, Nov., Dec., 1904, pp. 833–857.

Monogamous matings seem to be the rule with all the cranes and rails, with their allies, near and remote.[1]

Probably no group of birds in the world's entire avifauna have been more closely studied or had more written about them than the great gallinaceous group of fowls, including among them not a few other such familiar birds as the turkeys, the guinea fowls, quails, partridges, grouse, pheasants, and their various allies, near and remote. Good and sufficient reasons there are for this, as a very large number of them are, and have been, long domesticated, as the chickens and turkeys. All of them constitute game in every part of the world; while many of them are kept in zoological gardens and private preserves, as the pheasants and others. None of the Galliformes, I believe, are polyandrous, though many of the families are curiously divided up between polygamy and monogamy, some being strong adherents of the first-named practice, while others, under no circumstances, depart from the latter mode of mating.

Captivity sometimes influences these habits, and birds that are polygamous in nature become monogamous when their domestication is undertaken, and *vice versa*. Beautiful accounts have been given us by different naturalists of the often extraordinary courtships to be seen in the case of many of the representatives of this suborder of birds, while in other cases there habits are still quite unknown to science. Whether the Hemipodes or button quails (Hemipodidæ) are polygamous or not, I cannot at this writing say, but it is a well known fact that with them the females are brighter plumaged while the males, resembling the subadult specimens, perform all the duties of incubation. All this is

[1] *Loc. cit.* pp. 851, 852. It is here intended to include the supersuborders Gruiformes and Ralliformes. Curious and puzzling forms of birds occur in the first assemblage (Grues) such as the trumpeters (Psophia), the seriema (Cariama), the sun-bitterns (Eurypyga), the kagu (Rhinochetus), and the Mesitidæ of Madagascar. Although many of these have been long known to ornithologists, and much written about them, it is by no means certain that they are all monogamous species in nature, as I believe the finfoot (Heliornis) among the Ralliformes to be. Several of those named have been kept in zoölogical gardens, where they have reared their young, but a bird may be monogamous in captivity and polygamous in nature. Both the sun-bitterns and the kagu practice a show-off, but it does not appear to be confined to the breeding season or to their modes of courtship.

reversed in the little common quail of the old world (*Corturnix communis*), a well-known polygamous species, where the males are both larger and handsomer than the females.

As to the Megapodes or brush turkeys (Megapodidæ) of the East Indies and Australia, none of the writers at hand state whether they are polygamous or otherwise.

The habits of these birds are pretty well known, especially their burying their eggs in immense mounds which they build, or concealing them in sand-holes and burrows, in either situation they hatch out by the sun and the heat of the fermenting vegetable matter in the mounds. The young fly an hour after they are hatched. Wallace describes several species of them in his "Malay Archepelago," but does not state whether they are polygamous or not, and neither Newton or Pycraft have anything to say upon that point.[1]

Most ornithological writers lay it down as a rule that among the Gallinæ generally, where the cock bird is evidently larger than the hen and its plumage is remarkably conspicuous, the hen, being more or less plain in this particular, the species is polygamous, whereas, when the sexes are nearly alike in point of size, and but little difference in plumage, they are almost certain to be monogamous in their mating. There are, however, a few exceptions to this rule.

Personally, I have never studied the curassows and guans (*Cracidæ*) in their native haunts, and therefore cannot say, from my own experience, anything in regard to their mating habits. In this group, I take it, the curassows of South America are probably monogamous, as is likewise our Chachalaca (*Ortalis v. maccalli*), though in the case of the latter species, where the sexes are nearly alike, few American ornithologists describe its courtship and mating, notably Bendire, Coues, Ridgway (Manual), and others, while continental writers rarely refer to it. Neither Audubon or Wilson ever saw the bird.

Finally, the suborder Gallinæ is seen to contain five very ele-

[1] *Loc. cit.* Art. "Megapode" Pt. ii, p. 539, and Pycraft, "Living Animals of the World" Lond. p. 411. One writer states that several hen megapodes may bury their eggs in the same mound, but does not say whether the birds all belonged to the harem of one male.

gant families of birds, representatives of which, in more or fewer species, are found in all parts of the world. These are the pheasants (Phasianidæ), the grouse (Tetraonidæ), the American Partridges (Odontophoridæ), the Guinea fowl (Numididæ), and the Turkeys (Meleagridæ). Great is the wealth of species in the most of these several families, and while some of them are polygamous, others are strictly monogamous, and the habits of any of them may be changed through domestication, and they sometimes infringe upon, or even break, some of the rules given in foregoing paragraphs. Included in their ranks are all of our common domesticated gallinaceous fowl, and occasionally the habits of some of these are very remarkable.

Very much do I regret that I cannot give more space to this group as it is both an interesting as well as an important one; moreover, authors are by no means unanimous in their opinions in regard to the modes of mating, and in the case of some species we have apparently no data at all. Considerable part of the literature has been carefully looked up by me. No one seems to question but what such species as the capercailie and black grouse of northern Europe are polygamous. Pheasants and their near allies are likewise so, and I believe the famous Argus pheasant is, but in this I may be wrong. The wild turkeys of North America are also polygamists, though it is said that the old males generally have a favorite hen,while the other females he favors are but his concubines. Peacocks are polygamous but the various species of Guinea fowl are eminently monogamous. When the latter are domesticated, however, as vast numbers of them are, I have personally known a male Guinea fowl to take charge of six or seven hens, and the latter would all lay the usual number of eggs and bring forth their young. From all I can gather, it has been found that all the species of ptarmigan wherever they occur are monogamous. This seems to be the case too, with the birds we call quail (American partridges: Odontophoridæ), though I am not so sure about the species of the genus Cyrtonyx. The common partridge of Europe is monogamous, as are the majority of our typical grouse (Canada, dusky, Franklin's and others), the sage cock, however, is polygamous (Centrocercus).

Audubon, whose life-histories of our game birds are so thorough-

ly unsatisfactory, in his account of the mating of the pinnated grouse (Tympanuchus) gives one the impression that he believes the bird to be monogamous, while in his account of the ruffed grouse (Bonasa) he states in referring to the latter species, that "The males have the liberty of promiscuous concubinage, although not to such an extent as those of the pinnated grouse."[1] Bendire, on the other hand when describing the habits of the ruffed grouse (*B. umbellus*) says, "By many persons the ruffed grouse is considered polygamous, and while I can not actually disprove that assertion, I doubt it very much."[2]

Again authors are at variance in their opinions with respect to the several species of the sharp-tailed grouse (Pediocætes) and E. T. Seton, quoted by Bendire, says of the prairie sharp-tailed grouse in describing the remarkable dance of the males, "Its erratic character can hardly be questioned.... The whole affair bears a close resemblance to the manœuvring of the European ruff, and from this and other reasons I am inclined to suspect the sharp-tail of polygamy."[3]

The curious hoatzin of tropical South America (Opisthocomus) in a way related to the Gallinæ, is said to be polygamous, but as yet we stand quite in ignorance of some of the habits of this interesting form in nature.

Sand-grouse (Syrrhaptes) and their kin I believe are monogamous, and I do not at this writing recall any species of wild pigeon (Columbiformes) that has any other form of mating in the breeding

[1] Audubon, J. J. Birds of America, Vol. V, pp. 78 and 93–105, 1839.

[2] Bendire, Chas. E. Life Hists. Amer. Birds, p. 61. In the same work (p. 90), and quoting Judge John Dean Caton, he evidently believes the pinnated grouse to be monogamous, when it is stated that "It is toward the latter part of the love season that the fighting takes place among the cocks, probably by two who have fallen in love with the same sweetheart, whose modesty prevents her from selecting between them."

[3] *Loc. cit.* p. 105. I am of the opinion that this question has by no means been definitely settled yet, except perhaps in the case of the ruffed grouse which has been kept and reared in confinement by Mr. C. F. Hodge who says "The cocks of the ruffed grouse are evidently polygamous. I observed the "wild" cock mate with the two "wild" hens. The hens, however, permitted mating but once, and after mating, if left together, the cock will pick the hen to death." (Rep. of the Comm. on Fisheries and Game. Dec. 31, 1905 [Mass.] Pub. Doc. No. 25, pp. 66, 67.

season, though to me pigeons are by no means always so. Those birds known as screamers (Palamedæ) also appear to be monogamous, and I believe the entire swan, goose and duck tribe (Anseriformes) are,— at least in nature, although there may be exceptions to this that I either do not recall for the moment, or have not come to my notice. When domesticated, however, ducks may become highly polygamous, and it is a well-known fact that in this state it is not difficult to cross various species and rear interesting hybrids. Cases of this character are reported by Darwin, who states with respect to birds that "In several groups I have not been able to discover whether the species are polygamous or monogamous."[1]

"Very peculiar fancies," says Letourneau, "sometimes arise in the brains of certain birds. Thus we see birds of distinct species pairing, and this even in a wild state. These illegitimate unions have been observed between geese and barnacle geese, and between black grouse and pheasants," and further, when quoting Hewitt from Darwin as to how a common tame mallard duck threw over the male of own species and deliberately courted a male pintail that had been placed in the water with her, mated, and would have nothing further to do with the mallard, he says "that conjugal fidelity does not always resist a strong impression arising from a chance encounter; that novelty has a disturbing effect; and, finally, that indifference and coldness can rarely hold out against the persistent advances of one who loves ardently enough not to yield to discouragement. Dante has already made this last reflection in his celebrated line —

'Amor ch'a null' amato amar perdona.'

To quote Dante *à propos* of the illicit amours of a pintail and a wild duck may shock the learned, but the aptness of the quotation proves once more the essential identity of the animal and human organisms."[2]

Polygamy is not practiced, so far as I am aware, by any of the flamingoes (Phœnicopteri), or representatives of the crane-stork assemblage (Herodiones), or the diurnal Raptores including all the vultures (Accipitres), or the parrot group (Psittaci), or

[1] *Loc. cit.* pp. 219, 218.

[2] Letourneau Ch. *The Evolution of Marriage.* London, 1900, pp. 28, 29.

the owls (Striges), the Caprimulgine forms (Caprimulgiformes). None of the Coraciæ (rollers, etc.) I believe are polygamous, or the kingfishers (Halcyoniformes), or the Bucerotes, or representatives of such suborders as the Upupæ, the Meropes, the Momoti, or the Todi, but when we come to the humming-birds (Trochili) some authorities still seem to be in doubt, and no less a distinguished ornithologist than Mr. Salvin told Darwin that he was "led to believe that humming-birds are polygamous," [1] but, the present writer by no means entertains any such an opinion.

Comparatively speaking, very little is known of the courtships and matings of the Jacamariformes (jacamars and puff-birds) and the Trogoniformes (trogons), but I believe none of them to be polygamous in their habits, although if found to be so it would in no way surprise me, on account of the relations of the latter to the cuckoos.

When I say this I do not mean to imply that any of the cuckoos are strictly polygamous, and no writer seems to be perfectly certain on that point. What the mating habits of the touracos (Musophagidæ) is like, I am, at this writing unable to say, but it is very interesting and important for us to know. Those who have had opportunity to study them have, as in so many instances in ornithological history, overlooked all this. The literature upon the nidification of the cuckoos (Cuculidæ) would make many volumes so it is quite unnecessary to dwell upon it here. Their depositing their eggs in the nest of other birds is simply parasitism, and for all I know to the contrary, the European cuckoo may be the veriest polygamist in the world's avifauna, and the same is true of others of his kin that follow the same practice. It is not likely that these birds are monogamous, it being far more probable that they follow some form of promiscuity, or where there is a scarcity of males, even polyandry? All these remarks likewise apply to our cowbirds (Molothrus) of the Passeriformes, birds which I am quite sure from personal observation may be either polygamous, monogamous, promiscuous, or have recourse to concubinage, or perchance in some instances, may even be polyandrous, though

[1] *Loc. cit.* p. 219. I have never seen any evidence of this in an common eastern form, the ruby-throat, nor in any of those I have had the opportunity to study in the west.

it is only through the force of circumstances that birds are ever the latter, as some seem to contend.

Some of the breeding habits of Cuckoos in various parts of the world are truly remarkable, as witness those of this country (Crotophaga, Geococcyx and Coccyzus). It would appear, from what we know of its habits, that our Anis may be strictly polygamous (Crotophaga), inasmuch as several females of this species all lay their eggs in the same nest,— but even so, they may be the mates of different males.

There are some wonderfully interesting questions that arise, when we come to study the courtships, mating, and nidification of the cuckoos, cuckoo-like birds, and the cowbirds, and especially when we apply this knowledge, in a comparative way, with the customs followed by our own species. Space, or rather its limitations, will not admit of my discussing any such matter here. Furthermore, the author is at present engaged upon a volume that will take fully into considerations all such questions, and where sufficient data is available, endeavor to throw some light upon their significance. Right here I may say, however, that the reader cannot be too strongly commended to read in the present connection all that Darwin has to say with respect to birds in *The Descent of Man* (pp. 219–221 and 358–499); also Letourneau on the *Evolution of Marriage*.

Returning to the cuckoos for a moment, I find Dr. R. Bowdler Sharp has said of the common European species (*C. canorus*), "There can scarcely be any doubt that the number of males considerably exceeds that of the females and some naturalists not only speak of the species as polyandrous but declare that the female bird does all the courting." They are said to lay twenty eggs in one season.[1]

Other than those referred to above, I know of few other birds in the world that are given to polygamy, though I expect the breeding habits of some of them are wonderfully interesting, not to say curious. Little or no information is before me on such subjects with respect to some of the following suborders, namely the Pamprodactylæ, Capitones, Rhamphastides, Indicatores, Piciformes,

[1] Cuckoos, Royal Nat. Hist. Lond., R. Lydekker, Editor. This work contains some excellent general accounts of birds and their habits.

Cypseliformes, and the Eurylæmiformes, although I know of no species or family among these several groups that are not strictly monogamous by nature, while they may differ very widely in their habits of nidification. Unfortunately, we still know very little about the life-histories of the lyre-birds of Australia (Menura), and some naturalists believe them to be polygamous. Again, Darwin quoting Lesson says "that birds of paradise, so remarkable for their sexual differences, are polygamous, but Mr. Wallace doubts whether he had sufficient evidence."[1]

In closing this article it is well to note that what I have set forth in it has probably long been known to the majority of general and observing naturalists of each generation, but not so to the average reading public, and, unfortunately not to a great many people to whom the knowledge would be of considerable interest if not of positive value.

It is clearly shown that birds, as a Class among Vertebrates, in nature may, in mating, be polygamists, monogamists, or under certain conditions given to practices simulating polyandry, or, as some claim, actual polyandry. At present we have no knowledge of the origin, causes, and in the majority of cases, the needs of these various habits. The radical changes that birds, in most instances make in these particulars under domestication are often more easily explained. That the satisfaction of the sexual instinct and the equally imperative demand, on the part of nature, that the species be perpetuated, if possible, is the essential part of the explanation, there can be no question. No one in any way familiar with general biology, and the past and present life histories of animals on this planet, would for an instant claim that any of these mating habits in birds were of a criminal nature. It is only the

[1] *Loc. cit.* p. 219. The fact of the matter is the so-called birds of paradise differ widely among themselves in structure appearance and in habits; so it may be that some of them are polygamists and others monogamists,— and this is possibly, indeed, probably the case. On the same page as quoted above, Darwin remarks that the male widow-bird, remarkable for his caudal plumes, certainly seems to be a polygamist," and Lydekker in the *Royal Natural History*, quoting Mr. Bowker (p. 366 of Vol. iii), says of the paradise whydahs (Vidua), an African genus of birds the same to which Darwin refers, that one male not unusually mates with at least fifteen females. This species is frequently seen in captivity.

ignorant, the superstitious and narrow-minded who entertain such views. We have plenty of storks, black grouse, and even European cuckoos and American cow-birds among our own species, but the significance of all this, and its biological importance to our kind, I shall endeavor to point out in another connection later on.

ON THE WOOD RAILS, GENUS ARAMIDES, OCCURRING NORTH OF PANAMA

OUTRAM BANGS

For many years I have been gathering all specimens I could of the splendid, great Wood Rails of the genus Aramides with the hope of some day monographing the group. Unfortunately I have as yet been unable to bring together sufficient material from South America to attempt to include in review the forms of that country. I now have, however, a complete set of the species and subspecies of Middle America from Panama north to the northern limit of the genus in southern Mexico. A critical study of this material together with a number of skins kindly lent me by the United States National Museum, the American Museum of Natural History, and the Bureau of Biological Survey of Washington, which include the types of *Aramides plumbeicollis* Zeledon, *A. axillaris* Lawr. and *A. albiventris* Lawr. has induced me to publish now a short synopsis of the forms of Aramides occurring north of Panama.

My views expressed in the following pages will be found to differ a little from those of recent authors, such as Sharpe in Vol. XXIII Catalogue of Birds in British Museum 1894 and Biologia Centrali-Americana, Aves, 3, 1897–1904, and I describe as new one form from Mexico, allowing to the region here treated three species and two additional subspecies.

In all species of Aramides the sexes are alike in color and there are but slight individual or seasonal differences, apart from those caused of the wholly mechanical processes of fading and wear. Some species have a juvenile plumage, still worn when the bird is nearly full grown, that is quite different in color from the livery of the adults — *A. axillaris* and its allies. Other species, apparently (I have seen but one young individual of *A. albiventris plumbeicollis*, and none at all of the other subspecies of *albiventris* or of *A. cajanea*) do not have a young plumage that is very distinctly different in color from that of the adults.

If the specimens examined by me are correctly sexed, there is also no average difference in size between the sexes in any of the species or subspecies. All, however, vary much in size individually, in fact to a degree I am wholly unable to account for.

KEY TO THE SPECIES AND SUBSPECIES OF ARAMIDES OCCURRING NORTH OF PANAMA

A. Sexes alike in color.
1. Under wing-coverts banded black and white
A. axillaris Lawr.
1. Under wing-coverts banded black and cinnamon-rufous or hazel . . . . . 2.
2. Back of head, between gray forehead and gray neck not distinctly chestnut, but grayish-brown or brownish-gray
A. cajanea (Müll.).
2. Back of head distinctly chestnut . . . . . 3.
3. Back concolor, olive . . . . . 4.
3. Back not concolor; olivaceous-tawny anteriorly, olive posteriorly . . . *A. albiventris plumbeicollis* (Zeledon).
4. General color paler; light colored crescent around the black belly patch, very wide, white
A. albiventris albiventris Lawr.
4. General color darker; light colored crescent around the black belly patch, narrow, fulvous
A. albiventris mexicanus nobis.

ARAMIDES AXILLARIS Lawrence

Aramides axillaris Lawr. Proc. Phil. Acad. p. 107, 1863. Sharpe Cat. Birds Br. Mus. **23**, p. 56, 1894. Biol. Cent. Am., Aves vol. **3**, p. 318, pl. LXXVII, 1897–1904.

TYPE LOCALITY. Barranquilla, Colombia. Type, now No. 45655, American Museum of Nat. Hist., New York, examined.

GEOGRAPHIC DISTRIBUTION. British Guiana, Trinidad, and northward through Venezuela and Colombia to southern Mexico.

It has been supposed that there was a break in the range of this species and that it did not occur in southern Central America south of Honduras. There is, however, in the Underwood collection, lately purchased by John E. Thayer Esq., a young example

of *A. axillaris*, nearly full grown but with the under parts still brownish slate-color, from Costa Rica. Unfortunately the label bears nothing more definite than "Costa Rica." While certainly very rare in southern Central America, I still believe *A. axillaris* has a continuous range. It is a rare species in northern South America, and seems to be nowhere so plentiful as in the region lying between southern Mexico and Honduras. At all events I can detect no difference between northern and southern specimens.

CHARACTERS. Size small; bill short; under wing-coverts banded blackish and white; neck and head, except throat, rufous-chestnut; a conspicuous gray patch occupying upper interscapular region and lower hind neck.

COLOR. Adult plumage. Throat white; head, neck and breast bright rufous-chestnut; upper interscapular region and lower hind neck gray (about slate gray); back, wing-coverts and wings except primaries and secondaries, olive; rump brownish black; tail and upper and under tail-coverts, black; belly and thighs slate-color; primaries hazel; secondaries also hazel but duller, more dusky toward tips; under wing coverts and axillars banded black and white; bend of wing and tips of axillars usually banded black and hazel; "tarsus vermilion; beak green, basal portion yellow; iris brown."[1]

Young differ from adults in having the neck and under parts dull slate-color, and the characteristic gray patch on lower hind neck and upper back less distinct though still evident.

MEASUREMENTS.

No.	*Sex & Age*	*Locality.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
45655[2]	Type —	Colombia, Barranquilla.	171.	60.	57.5	44.
6159[3]	♂ ad.	Colombia, Chirua.	166.	57.	57.	43.
167364[4]	♂ ad.	Yucatan, Mujeres Isl.	165.	58.	54.	41.
141535	♂ ad.	Mexico, Guerreo, Acapulco.	168.	54.	56.	43.
157363	♂ ad.	Mexico, Tepic, San Blas.	169.	60.	60.	45.
50871[5]	♂ yg. ad.	" " "	166.	—	57.	42.5
52844	——	Mexico, Mazatlan.	170.	58.5	54.5	42 5

[1] From notes made from fresh specimen by W. W. Brown Jr.
[2] Coll. of American Museum of Nat. Hist., New York.
[3] Coll. of E. A. & O. Bangs, Boston.
[4] Coll. of Bureau of Biological Survey, Washington.
[5] Coll. of U. S. National Museum, Washington.

No.	Sex & Age	Locality.	Wing.	Tail.	Tarsus.	Culmen.
105554	yg.	British Guiana.	168.	53.	51.	39.
16375[1]	yg.	Costa Rica.	156.	50.	51.	40.5

REMARKS. *A. axillaris* is a small species with a short bill, related to *A. mangle* (Spix) of Brazil of which it is the northern representative. Judged by the few specimens I have been able to examine I should think the two were specifically distinct.

A. axillaris is very different from any species occurring in the same region with it, being at once distinguished by its small size, black and white under wing-coverts and red-brown neck. It does not appear to be subject to any geographic variation — southern and northern examples being, so far as I can see, quite alike.

ARAMIDES CAJANEA (Müller).

Fulica cajanea Müll., Syst. Nat. Suppl., p. 119, 1776, based on Daubent. Pl. Eul. pl. 352.

Rallus chiricote Vieill., N. Dict. d' Hist. Nat., **28**, p. 551, 1789.

Aramides cayanea Sharpe, Cat. Birds Br. Mus. Vol. **23**, pp. 57–58, 1894.

Aramides cayanea subsp. A. *Aramides chiricote* Sharpe, Cat. Birds Br. Mus. Vol. **23**, pp. 58–59, 1894.

Aramides chiricote Biol. Cent. Am. Aves, Vol. **3**, p. 318, 1897–1904.

TYPE LOCALITY: Cayenne.

Geographic Distribution: Tropical America in general from northern Brazil north through Panama and Chiriqui to the Pacific slope of Costa Rica.

CHARACTERS: Size large (in point of size *A. cajanea* and its allies occupy an intermediate position in the genus, being much larger than *A. axillaris* and allied species, but inferior to the gigantic *A. ypacaha* (Vieill.) of southern South America); bill long; under wing-coverts banded blackish and hazel; neck and head gray, duller, browner on occiput; back concolor, olive; breast, concolor bright, deep, reddish tawny.

COLOR: Throat dull grayish white; rest of head and neck gray (nearest slate-gray) this color sometimes extending a little

[1] Coll. of E. A. & O. Bangs, Boston.

onto mantle, darkest on forehead and palest on cheeks, the occiput darker, duller, often brownish — grayish-brown, brownish-gray or grayish-olive; back and wings, except primaries and secondaries greenish-olive; primaries and secondaries hazel, darker, dusky olive toward tips, the outer secondaries olive on outer edges, and inner secondaries mostly olive; rump black, often suffused posteriorly with deep reddish olive; upper tail coverts and tail black; breast deep reddish tawny, varying slightly in tone (with season or age?), sometimes toward hazel sometimes toward orange-rufous; belly and under tail coverts black; thighs slate color; under wing coverts and axillars banded black and hazel; "tarsus poppy-red; terminal part of bill green, basal part yellow; obital ring red; iris red, *soon after death changing to brown.*"[1]

MEASUREMENTS.

No.	*Sex & Age.*	*Locality.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
11398[2]	—	Brazil, Santarem	180.	56.5	69.	51.
121110[3]	♀ ad.	Brazil, Diamantina	172.	64.	68.5	50.
15408	—	Brazil.	168.	58.	68.	52.5
16536	—	"	185.	70.	68.	57.
9942[2]	♀ ad.	Surinam, Paramaribo.	176.	61.	70.	57.
9943	♀ ad.	" "	168.	58.	68.	52.
17940[3]	—	Darien, Atrata.	177.	—	69.	—
148191	—	Panama.	175.	63.	71.	52.
7060[2]	♂ ad.	Panama, Loma del Leon.	173.	65.	69.	55.
7650	♀ ad.	Chiriqui, Divala.	177.	60.	72.	53.5
7649	♂ ad.	" "	185.	61.	71.	56.5
40386[3]	—	Chiriqui, David.	176.	60.	65.	54.
40392	—	" "	172.	66.	72.	55.5
132265	♂ ad.	Costa Rica.	190.	65.	71.	54.
64997	—	Costa Rica, Talamanca Dist.	182.	66.	68.	57.
64998	—	" "	184.	58.	72.	54.
67900	—	" "	175.	57.	69.	54.5
67905	—	" "	189.	54.	69.	50.5
16373[2]	♀ ad.	Costa Rica, Pozo Azul.	184.	59.	71.	53.5
16374	♂ ad.	" "	180.	63.	72.	57.
14297	♀ ad.	Panama, San Miguel Isl.	163.	58.5	67.5	52.
14298	♀ ad.	" "	170.	64.	66.	52.
14299	♂ ad.	" "	165.	59.	67.	52.
40343[4]	♂ ad.	" "	169.	—	67.	53.

[1] Notes made from freshly killed examples by W. W. Brown, Jr.

[2] Coll. of E. A. and O. Bangs.

[3] Coll. of United States National Museum.

[4] Coll. of Museum of Comparative Zoology.

REMARKS. After very careful comparison of a large number of specimens I fail altogether to make out a subspecies, *chiricote*. I can find no constant differences whatever between skins from Brazil and Surinam on the one hand and the most northern examples from Chiriqui and Costa Rica on the other. Indeed Sharpe in Catalogue of Birds in the British Museum (Vol. **23**, pp. 57–59) does not assign any well defined geographic distribution to the two subspecies he recognizes. The patch of a duller color on the occiput varies considerably in shade — with season I think, that is with the condition of the plumage, whether fresh or much worn. Different examples from Panama and Costa Rica differ quite as much in respect to the shade of color and distinctness of this marking as do any two that can be picked out from the northern and southern parts of the range of the species.

Inhabiting the Pearl Islands in the Bay of Panama is a slightly paler and slightly smaller race of this rail. The four examples taken there by Mr. Brown cannot quite be matched by continental specimens, but the differences are too slight and in this genus of two unimportant a nature to base a subspecies upon.

There appears, however, to be in Brazil a well marked subspecies, the exact range of which I am through want of sufficient material unable to define. Skin "f" of Sharpe's list in Catalogue of Birds, belongs to this form (see footnote, p. 58) and there is one skin in the National Museum, No. 24124 from (St. Catharines ?) Brazil collected by Lemuel Wells, that appears to agree exactly with Sharpe's Rio de Boraxudo specimen, differing from *A. cajanea* in being mostly gray above, the gray of the upper neck pervading the entire mantle, the wing coverts alone being olive and these paler and decidedly more grayish olive than in *A. cajanea*; the rufous color of under parts, as pointed out by Sharpe in his specimen too, is also paler. This bird is not *Gallinula ruficeps* Spix, which, judged by the plate, is true *A. cajanea*, and undoubtedly represents a valid form.

Another peculiar individual is a very old skin in the National Museum, no. 15407, labeled "Buenos Ayres, J. K. Townsend ♂." In color this example agrees with true *A. cajanea* except in having the rump nearly wholly dark reddish olive. It is, however, very much larger with proportionally shorter tarsus and bill, the wings,

considerably worn at that, measuring, 200, tail 86, tarsus 73, culmen 55. It may represent still another subspecies.

Thus while in the northern part of its range from northern Brazil north, this rail does not vary to any extent with geographic areas, there seem to be in southern South America several geographic forms.

Aramides cajanea is another very distinct species, nearly allied only to *A. albiventris* Lawr. From that bird it can always be distinguished by its shorter, thicker bill, and duller color of the occipital region, which in *A. albiventris* is always bright chestnut.

Aramides albiventris albiventris Lawr.

Aramides albiventris Lawr. Proc. Phila. Acad., p. 234, 1867.

Aramides cayanea, subsp. B. *Aramides albiventris* Sharpe, Cat. Birds. Br. Mus. Vol. **23**, 1894, pp. 59–60.

Aramides albiventris Biol. Cent. Am., Aves, Vol. 3, p. 319, 1897–1904.

Type Locality; British Honduras, Type, now 45656, American Museum of Natural History, examined.

Geographic Distribution: British Honduras and Yucatan, and parts of Guatemala. Exact limits of range not known.

Characters: About the size of *A. cajanea* or slightly larger; bill longer and more slender than in that species; all the colors pale; a large, conspicuous patch of bright chestnut extending from between eyes over occiput to upper surface of neck; white throat patch large, extending well down neck; black of belly surrounded by a wide crescent shaped marking of white; under wing coverts banded black and pale hazel.

Color: Throat dull white, this color extending well down under surface of neck; on the occiput, extending backward to upper neck and forward to between eyes, a conspicuous patch of chestnut; rest of neck and head gray (about Gray No. 6 of Ridgway); back pale greenish olive; scapulars and sometimes outer interscapulars as well ochraceous-rufous more or less mixed with olive, this marking usually very conspicuous, though never forming a complete mantle across back as in the southern subspecies *plumbeicollis*; primaries and secondaries, light, bright hazel;

rump black, somewhat dusky olive anteriorly; upper tail coverts and tail black; breast pale tawny-ochraceous becoming ochraceous-buff posteriorly; a wide crescent shaped marking of white or sometimes cream-buff, around upper part of black belly patch; belly and under tail coverts black; thighs slate color; under wing coverts and axillars banded black and pale hazel, the tips of the feathers sometimes buff.

MEASUREMENTS

No.	*Sex & Age.*	*Locality.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
45656[1]	Type	British Honduras.	186.	62.5	80.	63.5
——— [2]	—	Belize, British Honduras.	180.	65.	74.5	60.
130325	—	Yucatan	176.	57.	74.	60.5
130326	—	"	177.	59.	76.	64.
130327	—	"	177.	58.	80.	65.
148192	—	"	184.	62.	77.	—
15246[3]	♂ ad.	Yucatan, Rio Lagartos	177.	63.5	74.	62.5
33668[3]	—	Guatemala, Chiapam	187.	62.	78.	66.
42777	—	Central Guatemala	176.	58.	75.5	66.

REMARKS. Typical *A. albiventris* occurs only, so far as I know, in the coast region of British Honduras and Yucatan, and in its very pale coloration parallels other bird forms of the same region such as the clapper rail, lately named *Rallus pallidus* by Nelson.

Two specimens from Guatemala I refer here, though they are intermediates, between *A. albiventris albiventris* and *A. albiventris mexicanus*, the one from central Guatemala being nearer to Yucatan and British Honduras examples, the other from Chiapam on the Pacific coast being more like the Mexican bird. To the northward true *A. albiventris* is replaced by a darker form with less distinct and more fulvous crescentic marking on the belly, that occupies southern Mexico and that I have named below as a new subspecies. Farther south in Central America *A. albiventris* is represented by a form — *A. plumbeicollis* — quite different in some details of coloration, and somewhat smaller, but still so like it in general that I have no hesitation in regarding the southern form as a subspecies rather than a segregate species.

[1] Coll. American Museum of Natural History.
[2] Coll. United States National Museum.
[3] Coll. E. A. and O. Bangs.

I find no indication of intergradation between *A. cajanea* and *A. albiventris* and must regard them as distinct species. The much longer more slender bill of *A. albiventris* and the conspicuous chestnut patch on the back of the head, always serve to distinguish it in all its subspecies from *A. cajanea*.

ARAMIDES ALBIVENTRIS MEXICANUS sub. sp. nov.

TYPE: from Buena Vista, Vera Cruz, Mexico, adult ♀, no. 2281 Coll. of E. A. and O. Bangs. Collected June 4, 1901, by A. E. Colburn and P. W. Shufeldt.

GEOGRAPHIC DISTRIBUTION: Southern Mexico, in States of Vera Cruz, Tabasco, Oaxaca and Chiapas, north to Hidalgo (one skin from Orizava no. 29231, U. S. Nat. Mus.) and on the coast at least to Tampico.

CHARACTERS: Very similar to true *A. albiventris*, but pale crescentic marking on belly, surrounding black belly patch much narrower and less distinct, strong buff in color, not white or cream buff; all the colors darker — gray of head and neck, greenish olive of back, and tawny of breast; much less suffused with ochraceous or tawny on scapulars and outer interscapulars though this marking is often indicated; throat less purely white, more grayish and this marking more confined, extending less onto under surface of neck.

MEASUREMENTS

No.	*Sex & Age.*	*Locality.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
2281[1]	Type ♀ ad.	Mexico, Vera Cruz, Buena Vista.	177.	54.	74.	64.
2280	♂ ad.	" " "	180.	56.5	76.	63.
141536[2]	♀ ad.	Mexico, Vera Cruz, Tlacotalpam.	179.	59.	74.	63.
141537	♂ ad.	" " "	185.	59.	73.	61.
141539	♀ ad.	" " "	173.	58.	77.	64.
58966[3]	—	Isthmus of Tehuantepec.	189.	60.	83.	73.
76990	—	"	185.	67.	78.	66.
29231	—	Mexico, Hidalgo, Orizava.	188.	64.	79.	67.
141541[2]	♀ ad.	Mexico, Oaxaca, Guichicovi.	182.	58.	73.	61.5
11012[1]	♀ ad.	Mexico, Tabasco	164.	60.	70.	62.
11013	♂ ad.	" "	184.	62.	80.	66.

[1] Coll. of E. A. and O. Bangs.
[2] Coll. of Bureau of Biological Survey, Washington.
[3] Coll. of U. S. National Museum.

REMARKS: *Aramides albiventris mexicanus* is the northern representative of this group of the genus, occupying the southern tier of states of the Republic of Mexico and southeastward passing gradually into true *A. albiventris* of Yucatan and British Honduras. Though well characterized subspecifically it is in general much like true *A. albiventris*. It can, however, always be told from that form by the characters pointed out above.

ARAMIDES ALBIVENTRIS PLUMBEICOLLIS (Zeledon)

Aramides plumbeicollis Zeledon Anales. Mus. Nac. Costa Rica, **1**, p. 131, 1887. Biol. Cent. Am. Aves, Vol. **3**, p. 320, 1897–1904.

TYPE LOCALITY: Jiménez, Costa Rica. Type now no. 113603, U. S. National Museum, examined.

GEOGRAPHIC DISTRIBUTION: Costa Rica, specimens examined from Jiménez, Carrillo, and Cariblanco de Sarapiqui, north at least to Segovia River, Honduras.

CHARACTERS: Similar to *A. albiventris mexicanus*, but slightly smaller; bill actually shorter, though relatively of about the same length; differing in color principally in having a complete mantle across upper back of olivaceous-tawny — the back thus bicolor, olivaceous — tawny anteriorly, greenish olive posteriorly; breast rather darker than in the other two subspecies more nearly as in *A. cajanea*; crescentic marking made by paler feathers around black belly patch, when present, narrow and buff in color (in two skins, one from Carrillo and one from Cariblanco de Sarapiqui this marking shows very distinctly; in the type and one other skin from type locality it is barely indicated).

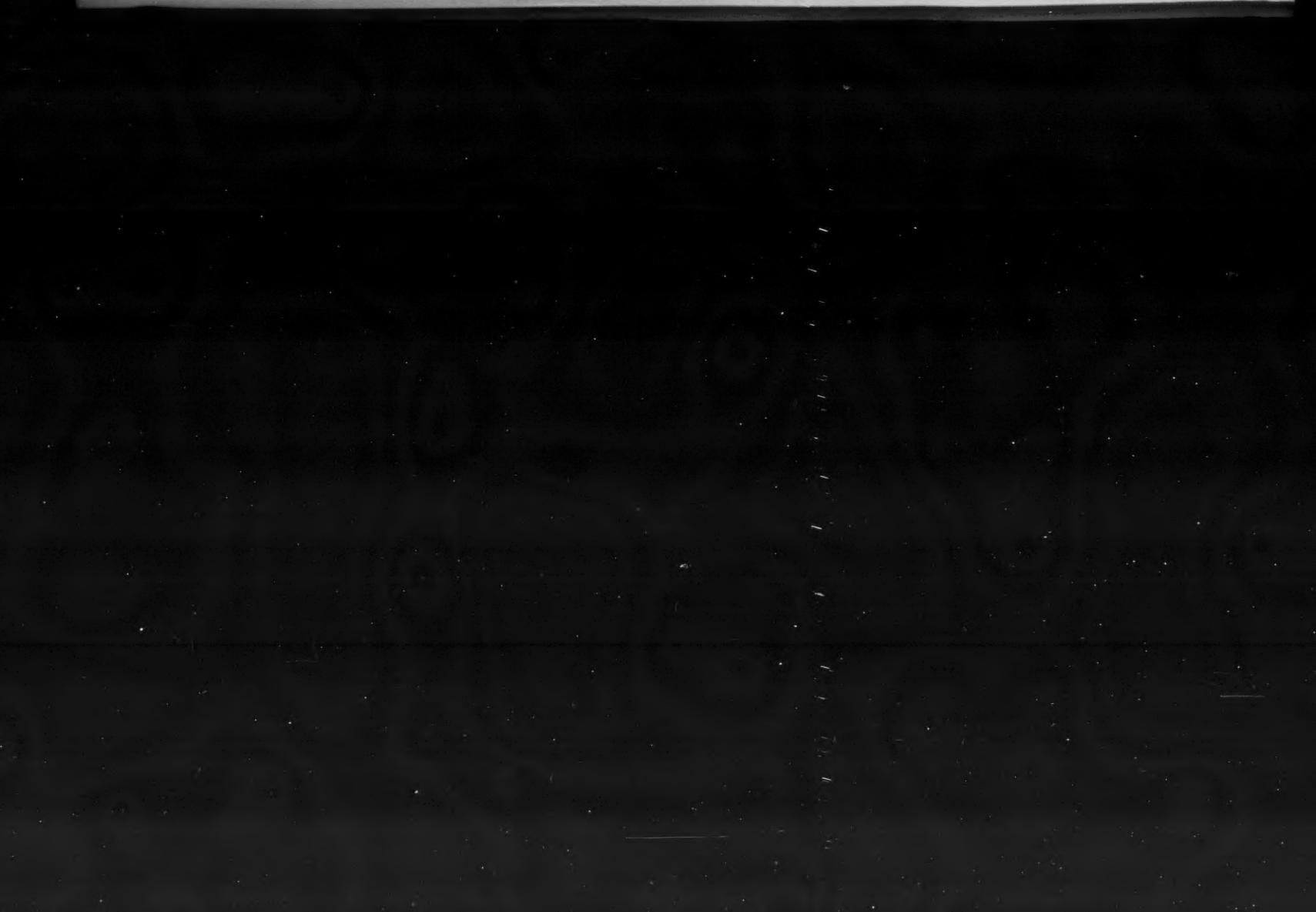
MEASUREMENTS.

No.	*Sex & Age.*	*Locality.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
113603[1]	♂ ad.	Type Costa Rica, Jiménez	173.	51.	74.	57.
115045	♀ ad.	" "	170.	53.	75.	—
16371[2]	♀ ad.	Costa Rica, Cariblanco de Sarapiqui.	172.	50.	75.	58.
16372	♀ ad.	Costa Rica, Carrillo.	175.	56.5	73.	61.
112254[1]	♂ yg.	Honduras, Segovia River.	173.5	58.	75.	53.

[1] Coll. of United States National Museum.
[2] Coll. of E. A. and O. Bangs.

REMARKS: I feel confident that I am right in placing this bird among the subspecies of *A. albiventris*, rather than to allow it specific rank. In all essential points — the long slender bill and chestnut color of the occiput and crown it agrees with *A. albiventris albiventris* and *A. albiventris mexicanus*. The brown mantle strikes one at first as a very strong point of difference, but this is in reality only a difference of degree, many northern skins showing a very decided approach to it, though it is in them never quite complete all across the back as it invariably is in the Costa Rican bird. The southern form is also somewhat smaller and darker in color below than either of the other two races, but every indication, in my opinion, points to its being a representative geographic form — subspecies — of the *A. albiventris* type.

The specimen from Segovia River, Honduras, unquestionably belongs here, as first pointed out by Richmond (Proc. U. S. Nat. Mus. **16**, p. 528, 1894). It is young, and as it happens is the only young example of any of these rails, except *A. axillaris*, that I have seen. The feathers of the underparts, especially the belly, are more fluffy than in the adults and in color it differs in the belly (black in the adult plumage) being black only at the base of the feathers which are externally tipped and suffused with the tawny color of the breast and in the rump, also clothed in fluffy feathers, being decidedly paler and browner. Though badly shot in the back and neck with many feathers from these parts lacking, the complete mantle of olivaceous-tawny is plainly to be seen. The bill is not full grown and is very immature in appearance. Judging from this skin it appears that the species of Aramides of this group do not have a brownish gray breasted juvenile plumage as does *A. axillaris* and its allies.



NOTES AND LITERATURE

BIOLOGY

The Reception of the Mutation Theory.— When the first Lieferung of "Die Mutationstheorie" appeared in 1901 a frequent question was whether the work would be made available for a larger audience by the preparation of an English translation. That the interest of Americans in this subject is very real was soon evidenced by an invitation extended to Professor de Vries to deliver a series of lectures at the University of California. A second edition of the thick volume containing these published lectures was necessary in a few months. Besides a French translation of the American lectures we now welcome an attractive German edition by Klebahn.[1]

Species and Varieties was reviewed in the pages of this journal (Am. Nat. **39**: 747–751, 1905) and it seems unnecessary to discuss the scope or contents of the work. The translator had the benefit of the corrections prepared by Professor de Vries so that the translation is comparable with the second American edition. An especially commendable feature of the present volume is a fine series of over fifty illustrations. These are drawn in part from the larger work of the author, in part from his unpublished drawings or photographs, and in part from living material or other sources.

It must be gratifying to all serious students of evolution to see the widespread interest in these works. Whether or not they admit the general applicability of de Vries's theory, they must at least realize that after long years of marking time students of evolution have at last begun to march. No one should scorn the results of comparative studies, but their limitations should always be kept clearly in mind. The spirit of experimental work is in the air and let us hope that there will be no turning back because of difficulties encountered in the way. Just here a word of warning may not be out of place. In experimental physiology and morphology it is considered essential that the factors involved and the results secured be quantitatively expressed. In ecology and evolution the impor-

[1] deVries, H. Arten und Varietäten und ihre Entstehung durch Mutation. Ins Deutche übertragen von H. Klebahn. Berlin. Gebrüder Borntraeger, 1906. Q. xii + 530 pp.

tance of quantitative methods is just as great. While de Vries was making the now celebrated experiments upon which his theory is based Pearson and his associates were developing the methods of quantitative investigation in variation and heredity. It will be unfortunate indeed if present day workers neglect this new and powerful instrument of research. But with a proper combination of experimental and biometric methods it should be possible to gain a very precise knowledge of the processes involved in species formation.

J. A. HARRIS.

A Monument to Theodor Schwann.— Theodor Schwann was born at Neuss on the Rhine, December 7, 1810. On the centennial of that date it is proposed to unveil a monument to his memory in his native town. A considerable sum is already in hand and a committee representing all countries has issued an appeal for subscriptions for the memorial. As is well known, he with Schleiden, placed the cell-theory on a substantial basis sixty-five years ago; while his later work was almost equally valuable though not so startling in character. He became an authority on fermentation, decomposition, digestion and spontaneous generation, and, not least, was the discoverer of pepsin. A monument to his associate has been erected in Jena while his master Johannus Müller has a bronze memorial in his native town, Coblenz. Contributions may be sent direct to the 'Städtische Sparkasse, Neuss am Rhein, Germany' marked 'Schwanndenkmal' or probably to the American members of the Committee, Prof. C. S. Minot of Boston and Prof. R. Ramsay Wright of Toronto.

Fitch's Basis of Mind and Morals.[1] — This book is a brief exposition of the principles of evolution as stated by Darwin and Spencer, together with a discussion of the evolution of mind and of the natural code of ethics. The point of view of the book is phenomenalistic; the style is simple, clear and direct. For those who have thought seriously about the problems of evolution the work has little value; for those who wish to be stimulated to such thought it may prove profitable.

The author contends that there should be a natural code of ethics. He does not attempt to construct such a code, but, instead states that it should be the result of man's knowledge of natural causes and

[1] Fitch, M. H. The Physical Basis of Mind and Morals. Chicago, Charles H. Kerr and Company. 1906. 266 pp.

effects. "But I repeat, he says that until men come to comprehend a natural cause for every natural effect they should be controlled in their attitude toward environment, including their brother men, by some code that will have the proper effect, however based that code may be." (p. 255.)

GEOLOGY.

The reconstruction of the Continents of Tertiary times is the topic discussed in a paper by W. D. Matthew.[1] Using the evidence furnished by the distribution of fossil and recent Mammals, he tries to reconstruct the outlines of the old land-masses, and illustrates his results by seven maps, which represent the geographical conditions of the earth's surface in Postcretaceous time (immediately after the close of the Cretaceous), in the middle Eocene, in the middle Oligocene, in the Miocene, in the Pliocene, in the early Pleistocene, and in recent times.

This paper undoubtedly marks an important progress in this branch of research. Comparing it with the last attempt to reconstruct the old continents, made by Ortmann in 1902 (Pr. Amer. Philos. Soc. **41**), we see that here only two maps were given, for the lower and for the upper Tertiary period. Neither agrees entirely with any one of Matthew's maps, although the one for the lower Tertiary corresponds rather closely to the middle Eocene map, and the one for the upper Tertiary to that of the Miocene. But complete agreement cannot be expected, considering the extreme difficulties with which such investigations are connected. Indeed, it is rather surprising that Matthew's studies, in many points, have led to results, which largely indorse the views held by Ortmann, and furnish additional support for many of the accepted features of ancient geography.

Studies of this kind are often regarded as rather phantastic and without sufficient support to render the conclusions trustworthy enough to give them universal recognition. But Matthew's paper again demonstrates that it *is* possible to express definite views as to the shape, the connections and disconnections of the continents,

[1] Matthew, W. D. Hypothetical Outlines of the Continents in Tertiary times. (Bull. Amer. Mus. Nat. Hist., **22**, 1906, p. 353–383. 7 maps).

chiefly in Tertiary times, and the agreement of the zoogeographical facts with paleontology and geology tends to show, that these reconstructions of the old continents are not merely wild speculations. However, the results cannot yet be accepted as final, and although some of the major features of old geography must be regarded as well established, much remains to be done in detail. Chief of all, additional groups of animals should be studied, and an attempt should be made to correlate the results obtained by them with those of Ortmann and Matthew; and further, attention should also be paid to the Mesozoic, and if possible, Paleozoic times. It is to be hoped that, for instance, the distribution of certain molluscs and lower vertebrates may furnish evidence with regard to these ages, although it is only natural that this task will be much more difficult, since the facts are very scanty, and their meaning is largely obscured by the changes in subsequent times.

A. E. O.

The Mountains of Cape Colony.— In the Cape Colony, southern Africa, are ranges of folded mountains very similar to the Alleghenies of the eastern United States. During the summer of 1905 Professor Davis had an opportunity to study the Cape Colony ranges while a guest of the British Association for the Advancement of Science during its South African meeting, and in this paper[1] has given a most interesting account of the ranges, comparing them with the Allegheny type. The paper will be of more than usual interest to American geologists and geographers, because of the striking similarity, in practically all essential features, of the two widely separated mountain groups, whether compared as to structure, the relation of folded areas to undisturbed plateaus, the erosion history and development of drainage adjustments, or the control exerted by the physiographic features upon transportation, etc. In climate, however, a marked contrast between the two localities exists. The paper is illustrated by a number of drawings and photographs.

D. W. J.

Natural Mounds.[2]— During the last two years a number of papers have been published describing and attempting to explain the origin of the natural mounds occurring in different parts of the country.

[1] The Mountains of Southernmost Africa. By W. M. Davis. Bulletin American Geographical Society, Vol. **38**, 593–623, 1906.

[2] Natural Mounds. By Marius R. Campbell. Journal of Geology, Vol. **14**, 708–717, 1906.

Mr. Campbell figures and briefly describes the mounds, reviews the various theories of origin, some ten in number, which have been advanced by various writers, and concludes from his own studies of the subject that the mounds have been built up by ants or small rodents, more probably by ants. A bibliography of the subject is appended to the paper.

D. W. J.

Ancient Glacial Periods.— During recent years the evidences of repeated glacial periods during ancient geological time have been accumulating so rapidly that whereas much doubt was cast upon the earlier reports of such glaciation, it is no longer possible for the unprejudiced student to doubt the conclusions which the evidence forces upon us. The famous Dwyka glacial formation of South Africa is now well known, and its equivalent in India, the Talchir. I. C. White and David White have recently reached the conclusion, independently, that the equivalent of these Permian or Permo-Carboniferous glacial deposits occurs in southern Brazil in what is called the Orleans conglomerate. Glacial deposits in Australia are reported from both the Permian and the Cambrian or older beds. A. P. Coleman has recently reported evidence of a lower Huronian ice age in Canada. Mr. Schwarz[1] discusses three glacial periods in South Africa, those in addition to the Permian Dwyka being most probably, according to the author, of Devonian and Archaean age. The relation of the glacial beds to other members of the general stratigraphic series is pointed out, and the evidence of the glacial origin considered. It is this last point which in every case is critical. The fact that a large number of reports of ancient glaciation are being published does not strengthen the evidence in favor of ancient glaciation in any particular case. Each reported instance must be critically examined as to the value of the evidence supporting it.

D. W. J.

[1] The Three Paleozoic Ice-Ages of South Africa. By Ernest H. L. Schwarz. Journal of Geology, Vol. **14**, 683–691, 1906.

PHYSIOLOGY

Hough and Sedgwick's Physiology.[1]— "The authors of this work believe that extensive and fundamental changes must be made in the elementary teaching of physiology, hygiene, and sanitation, if these subjects are ever to occupy in the curriculum of education the place which their intrinsic importance requires." This sentence from the Preface to this new book by two well-known professors of biology is the key-note to its importance, for their intention in this respect certainly has been fulfilled. Not only the students of high schools, academies, and colleges actually need to know the facts and principles set forth here, but so also does the long-graduated 'average man' if he would live well. Especially is it one more step towards the recognition educational theory is certainly about to make, that in education every part of a boy's body one is educating at the same time and in the most real manner also the capability of his whole mind.

The book is divided into two nearly equal parts: 'Physiology,' and 'The Hygiene of the Human Mechanism and the Sanitation of its Surroundings,' respectively. The latter half is subdivided into accounts of personal hygiene, domestic hygiene, and public hygiene and sanitation, with an important introductory chapter in addition.

The matter of the first part of the book is better than its arrangement in chapters, for the nervous system is placed last and the muscular mechanism early in the list. For the learner the much more preferable order is just the reverse, it being certainly difficult really to understand any one of the great organic functions until the coördinating purpose of the nervous system is mastered. One deplores too the omission of at least a brief discussion of protoplasm in general as an introduction to its differentiated natures.

A far more serious omission (but one more easily defensible) is that of the basal principles of reproduction. When all is said, at whatever length, one can but deplore the fashionable prudery of our times which keeps from youth the true and useful knowledge of their own real nature in this respect. With a decreasing birth-rate and an ever increasing 'social evil,' the information both sexes most crave is, above all others, most hard for them to obtain. The book is surely

[1] The Human Mechanism: its Physiology and Hygiene and the Sanitation of its Surroundings," Theodore Hough and William T. Sedgwick. Boston, Ginn & Company, [1907]. Pp. ix + 564. Illustrated.

not intended for grammar schools nor for the first years of the high school even, but for schools whose students might soon aspire to be husbands and wives.

The chapter on muscular activity is uniquely fine in its discussion of the necessity for physical exercise, and in combination with previous chapters on muscle-function and neural coördination almost meets the insistent demand pedagogy is beginning to make for bodily skill as a basis for learning. One misses, perhaps, an adequate description of the kinesthetic mechanism for muscular control, as well as sufficient information as to habit and the emotional reactions. On the other hand, 'rhythmic segmentation' is allowed far more prominence than the doubts as to its existence warrant.

The hygienic portion of the book is rich in clear and precise information of really great importance to everyone. Moreover it is set forth in a manner as scientific and up-to-date as could be desired. Could an enlarged wall-copy of figure 116 ("A domestic well badly situated in a farmyard"), be distributed broadcast by the state boards of health, our city hospitals would soon cease to be over-filled with typhoid patients in October and our farm-houses would be less saddened by cholera infantum in the summer.

The account of personal hygiene is at once eminently practical and entirely scientific — a needful combination seldom attained. Moreover it is more complete than is common in text-books of this sort. It seems as if too little emphasis perhaps, were placed on the importance of moisture in the air of dwellings, this need being met by continually open windows. It is the throat-specialists who best realize the general lack of moisture in the atmosphere of our houses, but there are of course other reasons (such as that moist warm air feels warmer than does dry warm air) which are important in the theory of ventilation.

Few but physiologists familiar with the required falsities as to alcohol and tobacco which reek in certain states, especially westward, will realize how excellent is the discussion of these very important topics in this book. The facts are clearly stated and the principles laid down,— their dangers in overuse any student in a school for normal persons may certainly see and be warned by for himself.

The 147 often familiar illustrations of the work are adequate and for the most part well executed.

Altogether this is an important text-book, not only in itself as a source of vital information for a host of young men and women, but as a prophecy of the present excellent trend of general education.

GEORGE V. N. DEARBORN.

ZOÖLOGY

Guyer's Animal Micrology,[1] though burdened with a horrible name, is one of the best and most practical works upon microscopic technique with which we are acquainted, ranking, in this respect with Böhm and Oppel's well-known "Taschenbuch" which, by the way, is not referred to in the list of works cited on p. vi.

The especial merit of the work lies in its great practicability. It does not burden the beginner with a large number of alternatives; but starts him at once with a few reagents of almost universal availability and sets him at work with his specimens. Only when these have been carried through and converted into slides are other methods and other objects considered.

In the Appendix are given an account of the microscope and its accessories, a list of further tried and proved reagents and a table of tissues and organs with methods of preparation which will doubtless prove of value to instructors as well as to students. The list which is given embraces over 250 objects and is more than ample to illustrate any practicable course in normal histology. The final chapter of the Appendix deals with methods preparatory to microscopic preparation and study of a series of animals which are frequently used in the Zoölogical Laboratory.

Omissions of what we would like to see in such a work are few. We have found no mention of Cox's Golgi method which presents certain advantages over the silver impregnation; the Golgi method for distinguishing bile capillaries is not referred to, nor is the value of Lyons blue for differentiating cartilage. The method of rolling wax plates for reconstruction, credited to Huber (p. 128), has been in use for many years. In the 'Memoranda' on p. 30 it is stated that material which is to be kept indefinitely should be put in tightly stoppered bottles, but there is no hint as to the injurious effects of the extracts of cork and that some other method of closure should be adopted. But why find any more fault with such a useful and excellent work?

J. S. K.

[1] Animal Micrology. Practical Exercises in Microscopical Methods by Michæl F. Guyer, Chicago, University of Chicago Press, 1906, pp. ix + 240. $1.75 net.

Mollusca of Illinois and Michigan.— F. C. Baker has recently catalogued[1] the Mollusca of Illinois, enumerating in all 332 species of which 91 are terrestrial and 240 are aquatic (the figures are the author's, the discrepancy is not explained). The Unionidae number 89. The list gives localities with considerable detail; no new species are described. Bryant Walker's catalogue of the terrestrial Pulmonata of Michigan[2] is more elaborate, giving descriptions and in most cases figures, with an outline of the synonymy of the 79 species recorded from the state. In the Introduction, besides general notes on distribution, adequate directions are given for the collection and preparation of specimens.

A monograph on Anurida.— Those in charge of the Liverpool Biological Society have, for several years past, been issuing a series of short Memoirs on the morphology, life history, and œcology of various typical animals and plants found in that region. The thirteenth of the series appears in volume 20 of the Proceedings and Transactions of the society. It deals with the interesting Collembolan, Anurida and is by A. D. Imms. The habits and structure are described from original observations; the account of the development is summarized from American writers. A bibliography of 102 articles is given and the whole is illustrated by four figures in the text and by seven plates.

Reichensperger describes (Bull. Mus. Comp. Zoöl., 43, Dec. 1906) a new species of Myzostoma (*M. vincentinum*) found parasitic on *Pentacrinus decorus* from St. Vincent.

BOTANY

A popular book on Canadian wild flowers.— In 1885 the venerable Mrs. Catherine Parr Traill was among the leaders in popularizing a knowledge of American wild flowers by presenting them untechnically and attractively to those who could or would not make their acquaintance through keys and manuals. Her pioneer course has been

[1] Bulletin Ill. State Lat. Nat. Hist. **7**, 1907.

[2] Published by the State Board of Geological Survey, as a part of the Report for 1905, Lansing 1906.

successfully followed in this country by many and excellent works of the same character. A new and revised edition of her book has now made its appearance.[1] Like the original, it has passed through the hands of Macoun and Fletcher, for the determination of the plants included; it should stimulate in many people of the present day that love for plants and their ways which comes through knowing what they are, and toward which the first edition did such good service two decades ago.

W. T.

Notes.— An interesting and appreciative sketch of de Vries, by a former assistant, Henri Hus, has been separately issued from *The Open Court.*

A handsomely printed volume of botanical studies presented to Kjellman on his 60th birthday has been distributed by the University library of Upsala.

A detailed account of the history of natural science in the Aberdeen Universities has been reprinted by Professor Trail from "Aberdeen University Studies."

Semon's terminology, "equally applicable to the movements of a plant or the thoughts of a man," is used by Francis Darwin in a lecture on associated stimuli, printed in *The New Phytologist* of November 30.

A lecture on "Mendelism and Microscopy" is published by Scourfield in the *Journal of the Quekett Microscopical Club* of November.

The viability of old seeds has been tested recently by Becquerel, as reported in the *Comptes Rendus* of June 25 last, and abstracted in the *Gardeners' Chronicle* of November 24.

A concrete presentation of the results of local ecological study of the modern sort is afforded by Woodhead's Huddersfield paper occupying no. 261 of the *Journal of the Linnean Society, Botany.*

Strasburger contributes an illustrated paper on the thickening of palm and screwpine trunks, to vol. 43, Heft 4 of the *Jahrbücher für wissenschaftliche Botanik.*

[1] Traill, Mrs. C. P. Studies of Plant Life in Canada. Toronto, William Briggs, 1906. 8vo. xvii + 227 pp., with 8 reproductions in natural colors and 12 half-tone engravings, from drawings by Mrs. Agnes D. Chamberlin.

Habit illustrations of a number of the economic plants of West Africa occupy Heft 5, Vierte Reihe of Karsten and Schenck's "Vegetationsbilder."

South American botany continues to receive important attention in the *Arkiv för Botanik* of Stockholm.

A morphological and anatomical study of *Ceanothus americanus* and *C. ovatus* is published by Holm in *The American Journal of Science* for December.

An extensive segregation of the components of *Rhus glabra* is effected by Greene in the *Proceedings of the Washington Academy of Sciences* of December 18th.

Agnes Chase publishes on Paniceæ in the *Proceedings of the Biological Society of Washington* of December 8.

An interesting study of the Euglenoid genus Dunaliella is published by Teodoresco in the *Revue Générale de Botanique* of September 15.

Pithyum de Baryanum is said by Raffill, in *The Gardeners' Chronicle* of November 10, to have proved a serious enemy of the Victoria, at Kew.

An illustrated monograph of Ravenelia is published by Dietel in vol. 20, Abt. 2, Heft 3 of the *Beihefte* zum Botanischen Centralblatt.

A practical account of the fungous diseases of tulips and their treatment is contributed by Klebahn to *Gartenflora* of November 1.

A small text book of fungi, including morphology, physiology, pathology, classification, etc., by Massee has been issued from the Duckworth Press of London.

A biographic sketch of Mitten, with portrait, is published in *The Journal of Botany* for October.

A new "Manual of the New Zealand Flora," conformed to the Colonial flora plan of the elder Hooker, and prepared by Mr. T. F. Cheeseman, has recently been published by the Government of New Zealand. The species that are admitted number 156 vascular cryptogams and 1415 phænogams, representing 382 genera and pertaining to 97 orders. Of the total, 1143 are peculiar to New Zealand; 366 also occur in Australia; and 108 in South America. Naturalized species have been excluded from the work; but over 600 such species are said to occur in the colony.

An excellent, conservatively handled, local flora, of a very rich region, is that of the State of Washington, by Professor Piper, recently published as vol. 11 of *Contributions from the U. S. National Herbarium*, an illustrated volume of 637 pages.

In contrast with the highly diversified flora of Washington, is the homogeneous flora of the Altamaha grit region of the coastal plain of Georgia, to which is devoted a volume of 357 pages, by R. M. Harper, forming vol. 17, part 1 of the *Annals of the New York Academy of Sciences*. In this region, comprising about 11000 square miles, only 814 species or varieties of vascular plants are recognized, and 75 of these are weeds. Mr. Harper's study has been carried out on the lines of ecological analysis with special reference to geographic distribution, and his paper is illustrated by a map and 28 half-tone plates which form one of the best series of such illustrations yet published.

Habit illustrations of antarctic vegetation are given by Skottsberg in Reihe 4, Heft 3–4 of Karsten and Schenck's Vegetationsbilder.

Further "Contributions to Canadian Botany" are being published by Macoun in current numbers of *The Ottawa Naturalist*.

The official precedings of the International Botanical Congress held at Vienna in 1905 have recently been issued from the Fischer press of Jena, in the form of a quarto brochure of vi + 262 pages: the scientific papers presented before the Congress form a similar quarto of vi+446 pages, freely illustrated, and published by the same house.

A polyglot code of the rules of botanical nomenclature adopted by the 1905 International Botanical Congress of Vienna, has been separately issued from the Fischer press of Jena. The pamphlet is indispensable for every phanerogamic herbarium. One of the most debated acts of the Congress was the adoption of a list of several hundred generic names which were considered so thoroughly established as to be exempted from supersession by earlier names which have failed to come into general use. This list is included in the pamphlet.

Raunkiaer discusses the biological types to be recognized in botanical geography, in a paper separately issued from the *Oversigt over det Kgl. Danske Videnskabernes Selskabs Förhandlinger* for 1905.

Professor Bray's "Vegetation of the Sotol Country in Texas," elsewhere published, is also printed in vol. 7 of the *Transactions of the Texas Academy of Sciences*.

For Juliana and Orthopterygium, Mr. Hemsley proposes a new Order, Julianaceæ, to go between Juglandaceæ and Cupuliferæ,—in *The Journal of Botany* for November.

Brand describes and figures under the name *Trifolium pratense foliosum*, a glabrous clover recently introduced into American cultivation from Orel, Russia. (*Bulletin no. 95*, Bureau of Plant Industry, U. S. Department of Agriculture).

A considerable number of new species of the orchid genus Acovidium are described by Ames in the *Proceedings of the Biological Society of Washington* of September 25.

The Department of Agriculture in India has begun the publication of an important series of botanical memoirs, from the Agricultural Research Institute at Pusa. The three numbers thus far received refer to "Fungus Diseases of Sugar Cane in Bengal," "The Haustorium of *Santalum album*," and "Indian Wheat Rusts." A fourth paper, on "*Gossypium obtusifolium*," and a fifth, "An Account of the Genus Pythium and some Chytridiaceæ," are also announced.

An account of Cratægus, as richly represented in the vicinty of Albany, has been separately issued by Sargent and Peck from *Bulletin 105* of the New York State Museum.

A colored plate of *Ribes cruentum* is given in *Curtis's Botanical Magazine* for November.

The first issue of *The Bulletin of the Pictou Academy Scientific Association* contains an account of the Myxomycetes of Pictou County, Nova Scotia, by C. L. Moore.

Huber publishes a synopsis of 18 recognized species of Hevea in vol. 4, no. 4, of the *Boletim do Museu Goeldi*, of Para.

The fondness of cats for *Actinidia polygama* is re-recorded by Fairchild in *Science* of October 19.

Several new Cuban grasses are described by Hackel in the first *Informe Anual de la Estación Central Agronómica de Cuba*, issued in June.

Among other papers on island botany, Supplement 4 of the current volume of *The Philippine Journal of Science* contains a list of known Philippine fungi, by Ricker.

Adams, in *The Irish Naturalist* for November, notes that a mold of fermenting hay thrives at an induced temperature as high as 135.5° F.

Magnus has separately issued from vol. 21 of the *Naturwissenschaftliche Rundschau* an account of the destructive mushroom parasite, *Mycogone perniciosa*.

An exhaustive account of a Sclerotinia-rot of apples is given by Molz in the *Centralblatt für Bakteriologie*, etc., Abteilung 2, of October 27.

A study of the influence of selected yeasts upon fermentation, with reference to cider making, by Moncure, Davidson and Ellett, forms *Bulletin 160* of the Virginia Agricultural Experiment Station.

The Ustilaginales of North America are revised by Clinton in the recently issued vol. 7, part 1, of "North American Flora," under the editorship of Professors Underwood and Britton.

A descriptive account of the economic plants of the world and of their commercial uses, by Freeman and Chandler, is being issued in fortnightly parts by Pitman and Sons, of London, under the title "The World's Commercial Products."

Brief descriptions, with 3-color illustrations, of the most noxious weeds or "proclaimed plants" of Victoria are being published by Ewart and Tovey in *The Journal of the Department of Agriculture of Victoria*.

An illustrated account of the seed of red clover, and its impurities, by Brown and Hillman, forms *Farmers' Bulletin no. 260*, of the U. S. Department of Agriculture.

Laubert gives an account of *Ambrosia artemisiæfolia* as a German weed in vol. 35, no. 5, of *Landwirtschaftliche Jahrbücher*.

Stockberger gives an economic account of *Spigelia marilandica* and its surrogates in *Bulletin 100, part 5*, of the Bureau of Plant Industry, U. S. Department of Agriculture.

A portrait of Lord Avebury forms the frontispiece to *Nature Notes* for October.

An account of the varieties of dates grown in the Figuig region is being published by Paris in current numbers of the *Revue Horticole de l'Algérie*.

"Date varieties and date culture in Tunis" is the title of *Bulletin no. 92* of the Bureau of Plant Industry, U. S. Department of Agriculture, by Kearney.

An illustrated practical guide to judging and selecting corn is given by Shoesmith in *Bulletin no. 139* of the Kansas Agricultural Experiment Station.

An economic account of the cultivation of *Agave cantula* in the Philippines is given by Edwards in *Farmers' Bulletin no. 13* of the Insular Bureau of Agriculture.

Gomolla gives an interesting account of vanilla cultivation and preparation in Africa, in *Der Tropenpflanzer* for October.

Chemical studies of Althusa, Grindelia and Pittosporum, by Power and Tutin, have recently been distributed as papers from the Wellcome Research Laboratories of London.

An interesting account of the use of tree bark etc. for bread making is given by Dillingham in the recently issued vol. 3, part 5, of the *Bulletin of the Bussey Institution* of Harvard University.

Some good root-habit photographs of Ficus are reproduced in *Arboriculture*, for October.

Biffen analyzes Mendel's laws of inheritance with reference to wheat breeding, and the inheritance of sterility in barley, in the recently issued Cambridge volume of reprints from vol. 1 of the *Journal of Agricultural Science*.

A second edition of De Vries' "Species and Varieties: their Origin by Mutation," corrected and revised under the editorship of Dr. MacDougal, has been issued by The Open Court Publishing Company. The frontispiece is an excellent but somewhat informal portrait of the author, at work.

Further evidence of the germicidal effects of copper is given, in official orthography, by Kellerman and Beckwith in *Bulletin no. 100, part 7*, of the Bureau of Plant Industry, U. S. Department of Agriculture.

Livingston publishes an important study of the relation of desert plants to soil moisture and to evaporation as *Publication no. 50* of The Carnegie Institution of Washington.

A paper on the effect of tension upon the development of mechanical tissues in plants, by Ball, is contained in vol. 7 of the *Transactions of the Texas Academy of Science*.

From a study of the strength of the bands which Thyridopteryx fastens about twigs, the results of which are published in vol. 17 of the

Report of the Missouri Botanical Garden, von Schrenk concludes that the radial force of twig growth may equal a pressure of 40 or more atmospheres.

A biographic sketch of C. B. Clarke, with portrait, appears in the November *Journal of Botany*.

A short account of the McKinley or Dinkey grove of big-trees is given by Guthrie in *Forestry and Irrigation* for October.

The Journals.— *Botanical Gazette*, November:— Chamberlain, "The Ovule and Female Gametophyte of Dioon"; Brooks, "Temperature and Toxic Action"; Cook, "The Embryogeny of some Cuban Nymphæaceæ."

The Fern Bulletin, October:— Fellows, "The Fern Flora of Maine' ; Gilbert, "*Polypodium vulgare* var. *alato-multifidum*, var. nov."; Clute, "The Genus Oleandra"; Negley, "Where Florida Ferns Grow"; Palmer, *Asplenium ebenoides* in Chester Valley, Pa."; Ferriss, "On Cultivating our Ferns"; Clute, "Rare Forms of Ferns,—I"; Squires, "A New Station for *Selaginella douglasii*"; Puffer, "The Rusty Woodsia in Cultivation."

Torreya, December:— Harper, "Some Hitherto Undescribed Outcrops of Altamaha Grit and their Vegetation"; Berry, "Leaf Rafts and Fossil Leaves"; Sheldon, "A Rare Uromyces."

Rhodora, November:— Hitchcock, "Notes on Grasses"; Blanchard, "Some Maine Rubi. The Blackberries of the Kennebunks and Wells —III"; Fernald, "Twelve Additions to the Flora of Rhode Island"; Leavitt, "Regeneration in the Leaf of *Aristolochia sipho*"; Fernald, "*Potamogeton spathæformis* a probable Hybrid in Mystic Pond."

Torreya, November:— Howe, "Some Photographs of the Silk Cotton Tree (*Ceiba pentandra*), with Remarks on the Early Records of its Occurrence in America"; Hill, "A Mississippi Aletris and Some Associated Plants"; Shafer, "*Hibiscus oculiroseus*"; Murrill, "How Bresadola Became a Mycologist"; Burnham, "A New Species of Monotropsis"; Blanchard, "A New Dwarf Blackberry."

Journal of Mycology, November:— Long, "Notes on New or Rare Species of Ravenelia"; Atkinson, "A New Entoloma from Central Ohio"; Kellerman, "Fungi Selecti Guatemalenses Exsiccati, Decade 1" [label data]; Morgan, "North American Species of Lepiota" (continued); Kellerman, "Index to North American Mycology" (continued).

The Ohio Naturalist, November:—Schaffner, Mabel, "The Embryology of the Shepherd's Purse"; Hambleton, "Key to the Families of Ohio Lichens"; McCleery, "Pubescence and other External Peculiarities of Ohio Plants."

The Plant World, October:—Arthur, "The Paired Seeds of Cocklebur"; Tullsen, "The Probable Origin of Key-Fruits"; Parsons, "Children's Gardens and Their Value to Teachers of Botany and Nature Study"; Blumer, "Wild Fruits and Shrubs of the Priest River Valley"; Taylor, "The Germination of the Morning Glory."

The Bryologist, November:—Fink, "Further Notes on Cladonias —VIII"; Hagen, "A Study of *Tetraplodon australis*"; Bailey, "Vancouver Island Bryology—I"; Lorenz, "Notes on the Mosses of Waterville, N. H."; Haynes, "Ten Lophozias"; Collins, "Notes on *Polytrichum commune*."

Bulletin of the Torrey Botanical Club, October:—Arthur, "New Species of Uredineæ—V"; Harper, "Notes on the Distribution of some Alabama Plants"; Piper, "Notes on Calochortus."

Journal of the New York Botanical Garden, November:—Britton, "Recent Explorations in Jamaica"; Underwood, "Report on the Condition of the Tropical Laboratory"; Taylor, "Collecting in the Mountains West of Santiago, Cuba."

Journal of Mycology, September:—Kellerman, "A New Plowrightia from Guatemala"; Arthur, "A New Classification of the Uredineæ"; Bain and Essary, "A New Anthracnose of Alfalfa and Red Clover"; Atkinson, "Two New Species belonging to Naucoria and Stropharia"; Morgan, "North American Species of Lepiota (continued)"; Hedgcock, "Some Wood-Staining Fungi from Various Localities in the United States"; Kellerman, "Notes from Mycological Literature—XXI," and "Index to North American Mycology (continued)."

Of Mr. Elmer's *Leaflets on Philippine Botany* the following articles have been issued:—Elmer, "Philippine Rubiaceæ," "A Fascicle of Benguet Figs," "Additional New Species of Rubiaceæ," and "Pandans of East Leyte"; and Copeland, "A New Polypodium and Two Varieties."

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